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SOME ROMAN AMPHITHEATERS.—I.

THE word "amphitheater" denotes a theater in which the spectators were placed all about the stage. Though the derivation of the word is Greek, the theater itself is distinctly Roman. The building was designed with a view of allowing the largest number of spectators to enjoy the sights of the show. In a dramatic representation it is necessary that the spectators should both see and hear the actors on the stage, but in the pageants and fights with men and beasts, a close view was not necessary.

The combats of the gladiators first took place in Italy in the rectangular forums, where temporary scaffolding was erected for the spectators. The Romans also had games and hunted beasts in the great circuses, but toward the end of the Roman republic, when the shows increased both in frequency and in costliness, special buildings were provided to enable a vast audience to witness the sanguinary games. There were in all over one hundred amphitheaters in the Roman empire, even including a few in the East. Some idea of the size of the amphitheaters may be obtained from the table on next page, which appears in Friedländer's "Darstellung aus der Sittengeschichte Roms." Other works give different figures.

The Colosseum of Rome is the most famous of all the amphitheaters, though it will be seen it is not the largest. At first, many of the provincial amphitheaters were built of wood and many serious accidents were caused by this method of construction. In time even the amphitheaters in the smaller places were built of stone. Advantage was then often taken of the natural slope in a hill to lessen the labor of construction. In many cases a narrow ravine between two hills was utilized. Though the conformation of the ground and the ideas of the officials and architects had some effect upon the general plan, still the common design of the amphitheater was not very widely departed from.

The modern city of Capua, founded A.D. 876, was erected on the site of the Casilium, a point which was conquered by Hannibal after a stout resistance. It contains little of interest except a museum of Campanian antiquities. On the same line of railroad, between Rome and Naples, is situated the prosperous little town of S. Maria di Capua Vetere, which occupies the site of the ancient Capua and contains some interesting ruins. Capua was a very old Etruscan town known as Vulturnum, but after it was occupied by the Samnites it was called Capua. Among the cities of Italy, Capua was second only to Rome, and soon became noted for its effeminacy and degeneracy. In the zenith of its fame it was the largest city in Italy, having 300,000 inhabitants. It entered into an alliance with Hannibal in B.C. 216, and it was reduced after a long siege, B.C. 211. Its punishment was severe, its inhabitants being deprived of all civic rights. Under the Cæsars it regained its old prominence and continued prosperous until the war of the Goths, Vandals and Lombards. In the eighth century it was destroyed by the Saracens, and the inhabitants emigrated to modern Capua.

The most interesting remains at Capua are those of the amphitheater, which is supposed to be the oldest in Italy, and also one of the largest, and greatly resembling the Colosseum at Rome. Its relative size will be understood by reference to the table given on next page. It was capable of holding 100,000 persons. The ruins are magnificent, and they are specially adapted to show the construction of the substructures.

EXTERIOR OF THE AMPHITHEATER OF CAPUA.

Three of the corridors still exist in a tolerable state of preservation, and the remains of two more may also be seen. The corridors were entered by a series of arches, of which only two remain, although there must have been eighty in all; on the keystones are cut images of gods. The walls are composed of travertine blocks joined without cement. The part assigned to the spectators was called the "cavea." It was divided into several galleries concentric with the outer walls, and therefore of an elliptical form. The place of honor near the arena was called the podium, and it was arranged so that it would accommodate movable seats. The numerous passageways were divided so as to allow of the entrance and exit of the enormous audience without confusion. In order to provide for the exits and the seats, the architects were taxed to their utmost, but the integrity which much of the ruins exhibit to-day shows that they had a firm grasp of the problem.

ARENA OF THE AMPHITHEATER OF CAPUA.

The arena contains many substructions and compartments, which show the use to which the amphitheater was put. They are more perfectly found at Capua and Puzzuoli than elsewhere. When the arena at Capua was used for gladiatorial combats, the open space was covered with planks which were sanded. Many of the performances were aquatic, and the longitudinal tanks shown in our engraving were filled with water supplied by an aqueduct. All the vaults were lined with a peculiar cement which resisted the water, and large drains were provided to take it away rapidly. These canals were 10 feet deep, so it will be seen that very sizable triremes could be used. Round each of the openings there is a deep

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groove, as if a wooden cover had been tightly fitted over each and made watertight so that the arena could be flooded. Special facilities were provided for storing and launching the triremes. A dry dock, or cradle, to run in the boats has been found. The space between the canals was probably flooded with two or three feet of water, but the keels of the vessels probably rested in the smaller canals, and sometimes six vessels were used. In Capua remains of powerful lifts for vessels have been found. The smaller openings were largely used for "pegmata," or lifts which must have very much resembled our ordinary sidewalk elevators. They were used to raise cages of animals and to quickly remove the awful relics of carnage. We must leave the consideration of these lifts and the question of the awnings or velarium for a future article.

After the city of Capua had been destroyed by the Saracens, in the ninth century, the amphitheater was converted into a citadel and was totally ruined by the defense of the Saracens against Athanasius, Bishop of Naples.

Large schools for the training of the gladiators existed in Capua, and it was here in B.C. 83 that the insurrection of the gladiators broke out under the leadership of Spartacus, the Thracian. The insurrection was with difficulty quelled by Crassus. Probably no piece is recited more frequently by schoolboys than Spartacus' "Address to the Gladiators."

Near Monte Cassino, at the old "Casinum," also on the road between Rome and Naples, is another amphitheater in a very perfect condition. It is a good example of a small, cheaply constructed amphitheater for towns, as only powerful cities could afford travertine and other cut stone. The rough masonry is covered with a veneering of brick work, the so-called "opus reticulatum." According to an inscription preserved at Monte Cassino, the amphitheater was erected by

AMPHITHEATER AT MONTE CASSINO.

Ummidia Quadratilla at her own expense. The foundress is mentioned by Pliny in his letters as a lady of great wealth, who up to a very advanced age was an ardent admirer of theatrical performances. It will be seen that advantage is taken of a hill to lessen the expense of construction.

The following table shows the size of several famous amphitheaters:

	Entire Building.		Arena.	
	Greater Axis.	Shorter Axis.	Greater Axis.	Shorter Axis.
Puzzuoli	626½	475	367	216
Rome (Colosseum)	616	510½	281	176
Falerii	586½	348	...	...
Capua	557	458	250	150
Julia Cæsarea	551	289	459	197
Italica (Seville)	513	439½	...	...
Verona	505½	403	248	145½
Tarraco	486	390	277	181
Thysdrus	457	392	253½	188
Pola	452	369½	230	147
Arles	448	352	228	129
Pompeii	445	341	218½	115
Tours	443	393½	223	98½
Nismes	433¼	332½	227	126½

The temperature of an acetylene flame is variously estimated between 2100 degrees and 2420 degrees.

TRADE IN ANCIENT ASSYRIA.*

THIS little book belongs to a projected series of volumes which we gather are intended to deal with the Babylonians and Assyrians and other allied Semitic races, "the object of the series" being, according to the prospectus, "to state its results in popularly scientific form." The volume assigned to Prof. Sayce, which is the first of the series to make its appearance, describes the life and customs of the Babylonians and Assyrians, a subject which offers many points of interest to the general reader. Moreover, within recent years, much new material has been published which has thrown considerable light on the social condition of the Babylonians and Assyrians during both the earlier and the later periods of their history. Thousands of clay tablets, which were unearthed at Telloh in Southern Babylonia and have found their way into the museums of Europe, contain temple-records, lists and inventories, receipts and tablets of accounts, and furnish a glimpse of the daily life of the early inhabitants of Babylonia at about 2500 B. C. The letters and commercial documents of the period of the First Dynasty of Babylon enable us to form a still more intimate acquaintance with the life of the Babylonians under some of the earliest of their Semitic kings; while the systematic publication of the legal and epistolary literature in the great collection of tablets from Kouyunjik has increased our knowledge of the social condition of Mesopotamia under the later Assyrian kings. Finally, the large collections of tablets of the Neo-Babylonian and Persian periods, which are now available for study, make it possible to trace the development of laws and customs down to the latest periods of Babylonian history. There is, therefore, no lack of material on which to base a sketch of the manners and customs of the Babylonians and Assyrians.

Prof. Sayce has written many popular books on this subject, and he is well qualified for the task he has undertaken; but we cannot help wishing that in one important point he had modified the plan on which he has compiled his volume. The book deals largely with small details, containing descriptions of sales of houses and lands and property, deeds of partnership, marriage contracts, receipts, records of loans, and numerous other commercial and legal transactions drawn from the thousands of "contract tablets" which have been published in various monographs and in the transactions and journals of different societies. Any book describing the life and customs of the Babylonians must necessarily draw upon this large and scattered literature in order to illustrate the general conclusions which the writer formulates. Prof. Sayce has made abundant use of this material, quoting and describing tablets freely; on p. 16, for instance, in one short paragraph, he refers to no less than nine separate documents of different dates. But from the first page to the last he has not given a single reference to the works in which the various tablets have been published, or any indication by which they might be identified; in fact, not including Biblical quotations, we have found only two references in the book (on pp. 1 and 66), and these are to the opinions of modern writers and not to original authorities. This is perhaps not Prof. Sayce's fault, but a defect in the general plan of the series, for it is possible that the editor has ruled that references to authorities are incompatible with "a popularly scientific" treatment. But whoever may be responsible, this defect detracts largely from the value of the book. No doubt the expert knows already where to look for the original texts quoted, and can control the various statements for himself; but the series is not meant for the expert. In the editorial preface, we are expressly told that it is intended to "be serviceable to students in colleges, universities, and theological seminaries, to the clergy, and to intelligent lay readers." The object of the work is, therefore, essentially educational; but without references it can prove but a poor guide or introduction to the study of the subject of which it treats.

Although doubtless hampered by this deficiency in the general plan of the work, Prof. Sayce has produced a very readable, though perhaps a rather rambling, little book. He has written attractively on the general character of Babylonia and its inhabitants, the constitution of the family, the system of education, commercial and social life, laws and government, letter-writing and religion. To treat all these subjects fully in some two hundred and sixty octavo pages is, of course, impossible; but the author has touched his subjects lightly, and some of his chapters contain valuable summaries, as, for example, that in which he describes the legal condition of women in Babylonia. The plan of writing vaguely without reference to authorities, however, is not conducive to strict accuracy, and we occasionally meet with a rather misleading generalization. The statement on page 102, for instance, that "no deed was valid without the seal or mark of the contracting parties" is not borne out by the facts, for many deeds of different periods are extant which bear neither seal impression nor nail-mark. On page 61 we are told that "the year was divided into twelve months of thirty days each, an intercalary month being inserted from time to time. . . ." Even for the Assyrian period this statement is probably not accurate, and it takes no account of the changes which the calendar underwent in the long course of Babylonian and Assyrian history. The arrangement of the calendar and the method of harmonizing the lunar and solar years are not yet accurately known in many of their details and are still subjects of controversy, but the student would not gather this from Prof. Sayce's statement. The evidence for cremation (pp. 62 ff.) among the Babylonians and Assyrians is far from being conclusive, and many scholars hold that it was not practised in Mesopotamia before the Parthian period. The statement on page 51 that the writing of the scribes was sometimes so minute that magnifying glasses were used for reading by the Assyrians, and that short sight "must have been common in the Babylonian schools," is, to say the least, rather fanciful, the only evidence for the statement being a circular crystal object found by Layard at Nineveh, and thought to be a lens, but the use of which is unknown. That there was ever "a monotheistic school" at Erech (page 262) would, we think, be difficult to prove, and the evidence for "human sacrifice" referred to on page 103 should surely have been given. It is, no doubt, a consequence of the omission of references that we sometimes come across repetitions in the book, as, for instance, the quotation referring to the Chaldeans and their ships in connection with Eridu on pp. 9 and 183; the suggested identification of Sar-ilu with Israel on pages 17 and 191, the description of the letter referring to a ferry-boat on pages 186 and 215, etc. Misprints, too, are not uncommon, as, for example, "the eighteen hundredths part" (page 114), "I will lie up five shekels of silver" (page 225), "Emutalum" for "Emutbalum" (page 211), "weight" for "night" (page 266), "bears" apparently for "beasts" (page 52), "cuneiplain" apparently for "plain" (page 211), and on page 157 we are told that "Aramaic became the lingua panca . . . in the commercial world." Prof. Sayce is probably not

* A review of Babylonians and Assyrians: Life and Customs. By the Rev. A. H. Sayce. The Semitic Series. London: John C. Nimmo. 1900.

to blame for such misprints, for the American editor was doubtless responsible for the correction of the proof sheets.—Nature.

THE AQUARIUM AT THE PARIS EXPOSITION.*

THANKS to two artists of great merit, Albert and Henri Guillaume, ably seconded, in the technical work, by M. Boucheron, the old and sympathetic director of the permanent exposition of the Jardin d'Acclimatation; by M. Colbs, sub-director, and the entire personnel of that institution, who were placed under the orders of these gentlemen, Paris finally possesses a model aquarium worthy of the name, and one whose success, instantaneous from its opening, increases day by day. It is the delight of strangers, here from all parts of the world, to see the marvels of the Exposition, which is, in fact, the greatest and most beautiful manifestation of artistic and industrial genius yet produced by the civilized world.

To M. Henri Guillaume belongs the honor of having overcome the innumerable difficulties arising in the course of the construction of the aquarium, built, as it is, below the level of the Seine, and hence necessitating entirely novel processes of decoration. By the ingenious use of glass, and wonderful skill in the disposition of light, the impression of vast size and great distances given to the visitor is almost overpowering—really marvelous.

Before touching a hand to their gigantic undertaking, the Messieurs Guillaume constructed a rough model, embodying their general ideas, which, on exhibition, at once captured the full board of administrators of the Exposition, and received the felicitations of the Municipal Council, who at once and on the spot accepted the proposition of the Brothers Guillaume, which was to the effect that they should have the sole right to exploit the aquarium to the public for nine years, the Exposition year not counted in.

Justly proud of their success, and with the sympathetic encouragement which they received from all parts of the world, the brothers at once took possession of the terrain that had been allotted to them, on the Quai de la Conférance, and established their workshops. From the very first, the work was hindered by difficulties arising from the proximity of the river, but with a wonderful fertility of resource, every difficulty was met and overcome. They surrounded the spot on which their structure was to be reared, on all sides and below, with a wall and floor of béton (artificial stone made of hydraulic cement, etc.), which effectually shut out the water.

Another immense job was cutting away the wall of the quay, which, at that point, is 3½ meters (about 11 feet 8 inches) thick and 9 meters (30 feet) deep, in order to clear the way for the entrance to the aquarium. The steel work to receive the great slabs of glass was another source of great trouble and anxiety, as will easily be understood when we state that the pressure from this source amounted to about 7,500 pounds to the square meter. These "slabs" or plates were manufactured at St. Gobian, and were 2 by 3·5 meters (80 by 140 inches) in size, the average thickness being 33 millimeters (1⅓ inch). They weigh from 500 to 700 pounds each.

The design of the builders of the aquarium was to produce on the visitors the illusion that they were walking on the bottom of the sea. They did not content themselves with showing them through plates of glass the marine fauna and flora—the monsters of the deep, great and small—disporting themselves amid marine vegetation; but with consummate art, by mirrors, the management of light, etc., they gave to the surroundings an appearance of immensity most absolutely deceptive. One requires but little imagination to convince himself that the avenues actually stretch before and around him for miles and miles; that this coral cave is as great as the grotto of Antiparos, or that yonder mass of basalt springing from the sea is another Giant's Causeway. Look whither he will, the visitor seems to be isolated in immensity.

The frames supporting the huge plates of glass are of steel, but to avoid oxidation, the metal has been given a coating of minium, on which is another of a cement devised especially for the purpose. The fitting of these plates so as to insure absolute tightness of joint, over so great a surface, was another source of anxiety, and was worked out by slow experiment. For some reason, neither india-rubber nor caoutchouc could be used, and recourse was finally had to a mass formed of pine rosin, red lead, and mineral wax (ceresin).

The sea water for the tanks is taken from the open ocean at some distance from the land, in order to avoid the possibility of contamination, and a line of tank steamers, belonging to the great English firm of Burnett & Sons, are employed in constantly renewing it. The amount used daily is 350 cubic meters (over 900,000 gallons), and the greatest care is exercised to keep the liquid up to the normal standard of mid-ocean. Its density is taken at stated intervals, as is also the content in oxygen, etc., any departure from the mean being at once corrected; if the specific gravity gets too high, filtered spring water, and if too low, sea salt, is added.

The water is kept in constant motion, the circulation being maintained by a natural flow from one tank to another, a portion finally escaping from the lowest or last tank. The escape water can be purified by washing with compressed air, and is returned to the tanks again.

Entrance to the aquarium is gained through two great doors, which open on a vestibule which recalls the grottoes of the coast of Brittany. To this vestibule, full of elegant boutiques or shops, where almost everything conceivable that is connected with marine life, at least, is sold, the public has free access. Here the visitor may buy books bound in nacre, ornaments of mother-of-pearl, fish scales, coral, etc., too numerous to mention. Here, too, embowered with gorgeous marine vegetation, with seaferns, corals, etc., is that great and well-known piece of statuary, the chef d'ouvre of Gauquie, the Triumph of Amphitrite.

A vaulted passage, straight and somber in aspect, built of rocks and corals, conducts one to the aquarium, where all the known and procurable fauna and flora of old ocean are "on exhibit."

* Adapted from the Journal d'Hygiene for the National Druggist.

The object that first catches the eye of the visitor is a shipwrecked vessel, the hull traversing one of the largest tanks, and seeming, by the deceptive arrangement already spoken of, to lose itself in the perspective. To add to the illusion of looking into the depths of the ocean, the floor is transparent, and beneath it electric projectors throw vari-colored lights through the tanks, disclosing the algæ, the fish, mollusks, crabs, lobsters, etc.

There are nine tanks in all. In the first is a reconstruction of the famous sunken temples of Puzzoli, submerged in the Bay of Naples, and discovered in 1750. In this tank is a great display of Pleuronectides or flat fish (soles, limandes, turbots, flounders, etc.), whose dark color and flat shape are an admirable natural protection against their enemies. By lying close to the bottom and keeping still, they escape any but the sharpest vision. In this tank, also, are the sea urchins, echini, etc.

In the second and third tanks (the tanks are separated by a very small space, and this is concealed by the arrangement of sea-weeds and marine vegetation generally), we are shown a sunken vessel, reposing on the bottom of the sea. It is the remains of the "Graf von Bismarck," of Bremen, which was sunk in the harbor of Cherbourg, and there found and bought by the concessionaires of the aquarium and resurrected for this purpose.

In this, which is the largest of the basins, are found the sea tenches, the rays, the torpedo fish, the various varieties of sharks, the Thallassites, Cheloneæ, turtles, gobies, crabs, sea spiders, etc. Here, too, are Schandriæ and plungers, and one may watch them, with their lanterns, circling around the rocks and marine debris.

The fourth tank contains crustaceans and various varieties of sea-anemones, whose rainbow hues transform the tank into a parterre of brilliant flowers. Here, too, we see night-shining pelagiæ, the shizostomes, and sea spiders, while on the borders, lobsters, crabs, etc., are engaged in epic combat.

The fifth tank, in which are large and beautiful stalactites, and the bottom of which is garnished with massive blocks of ice, contains the codfish, sturgeons, and other fish of Arctic seas, among them the redoubtable sea scorpion.

The sixth is adorned with basaltic rocks, black and gray, originating from discharges of lava from submarine volcanoes. Here are turbots, sea-spiders, hermit crabs, those queer crustaceans which have naturally a shell over the head and chest only, but are bare elsewhere, and which take possession of the empty shell of any other creature they may find—and an infinite list of others.

Polyps, zoophytes, madrepores, occupy the seventh tank, but the especial guests here are the corals, which are in great number and variety. Here are trees, alive and growing, belonging, not to the vegetable, but to the animal kingdom, and owing their growth to the slow but constant increment from the calcareous secretion of a polyp of the genus Alcyon. Here, too, we see the sea-dogs amid arches, volutes, curves, whorls, casks, ladders and the myriad other forms of coral architecture.

The charms of this tank and the never-ceasing source of wonder are beautiful sirens that glide around amid the waves, yet have no real existence; they are forms projected into the water by electrical appliances concealed from the observer, but they appear to be actually there, and to be made of solid flesh.

In the eighth tank are also polyps, principally sponges—strange creatures whose life-history is not yet fully known, but which are composed of almost innumerable species. Here, too, are mullets, crabs, and a great variety of marine life, including that queer gasteropod mollusk commonly known as the sea hare (why, the Lord only knows, since there is absolutely nothing about it to remind one of a hare).

The bottom of the ninth and last tank is covered with pebbles and rocks of various sizes, and in this there is an innumerable host of little fish, such as the hippocampus, sea-horses, and all sorts of queer crawling and swimming things. The rocks of the bottom are covered with turtles, crabs, etc. Here a perpetual battle royal wages between the various denizens, to the great entertainment of visitors, and especially of the small boy.

PROF. SPRING'S EXPERIMENTS ON PLASTICITY.

IN an article contributed to the Revue Générale des Sciences, Prof. Spring, of Liège, has summarized a number of his experiments on the agglomeration of materials under heat and pressure, says The American Architect. With all plastic bodies he finds that pressure alone is needed for the welding together of discrete particles, and if the particles under pressure consist of different metals capable of forming alloys, these alloys may be produced by the application of pressure only. Thus, copper and tin filings mixed together and compressed produce bronze, while copper and zinc filings form brass under the same conditions. On the other hand, a mixture of zinc and lead filings will not alloy any better under pressure than the two metals do when melted together. This welding together of the particles of a metal under pressure, and the production of alloys by mere compression, is attributed to the formation of a solid solution at the interfaces under pressure. Molecules of one fragment of iron will thus penetrate into the next, and, similarly, molecules of a fragment of zinc will pass into the body of an adjoining fragment of copper. This molecular mobility, however, differs from ordinary evaporation in that, for its exhibition, the presence of a mass into which the molecules can diffuse is needed. A molecule only passes from one fragment to another provided that it is replaced by a second molecule from the second fragment. To further investigate the matter, cylinders of different metals, having ends as flat as it was possible to make them, were prepared, and pairs consisting of one cylinder piled on another were placed in a stove and kept there for from three to twelve hours, at a temperature at least 300° Fah. below the melting point of the most fusible of the metals; and in the case of platinum, the stove temperature was 2,880° Fah. below the fusing-point of the metal. Nevertheless, a couple of superimposed platinum cylinders subjected to a pressure merely due to the weight of the topmost welded together in this stove, and the same was the case with all the couples in which the two constituents were one and the same metal. In fact, on turning up the cylinders afterward in the lathe, the joint could not be detected. When the pair consisted of metals capable of alloying with each other, union again took place; and in the case of the zinc-copper couple, a layer of brass $\frac{1}{1000}$ inch thick was plainly visible at the joint. On the other hand, metals incapable of dissolving each other such as zinc and lead, and zinc and bismuth, showed no signs of union when treated in the manner described. Prof. Spring has also extended his experiments to sand and grains of limestone and similar constituents of the earth's crust, in order to ascertain if the agglomeration of these materials into rock could be brought about by pressure alone. This was found to be impossible even when the pressure used was equivalent to that of a layer of rock 30 miles thick. Prof. Spring finds, however, that under high pressure water is capable of dissolving a fair amount of silica, which is deposited when the pressure is removed, and suggests that the cementing together of the grains of sand and carbonate of lime forming the bulk of our sedimentary rocks may have been effected in this manner. A solution of silica traversing a layer of sand, without the application of great pressure, will also deposit a cementing layer of silica; but to obtain success a slight pressure is necessary in order to keep the grains in contact during the contraction of volume accompanying the splitting up of the silicic acid, just as in gluing together two pieces of wood pressure is necessary until the joint has set.

THE EXPLOSION OF POTASSIUM CHLORATE.

POTASSIUM chlorate is an endothermic compound. The transformation $ClO^3K = KCl + O^4$ disengages + 11·9 cal., developing 35·5 liters of oxygen, or for one gramme, 97 cal. and 273 c.c.

However, potassium chlorate is not classed ordinarily with explosive bodies. It does not detonate under the influence of progressive heating, though it is decomposed with rapidity and an elevation of temperature, which may rise even to incandescence, when a small retort, containing a hundred grammes, is heated with naked fire.

I have caused it to detonate under ordinary pressure, in an open vessel and in an inert gas, by operating according to a method, or rather a principle, which I enunciated some time since as applicable in general to the reactions of endothermic systems. I refer to the reactions which preserve their indications and approximate value when the temperature is raised. It is sufficient to place it quickly in an inclosure, raised previously and kept at a temperature sensibly higher than that of the commencing decomposition. It is also necessary that the mass of matter composing the inclosure shall be so large that the introduction of the quantity of decomposable matter at the ordinary temperature may not be such as to lower materially the general temperature within.

I have shown how picric acid can be made to detonate, a compound which burns tranquilly when it is fused in a capsule heated over a gas jet, and ignited in contact with the air.

The same phenomenon, that is, the explosion, will occur with potassium chlorate. For the purpose a glass tube is used, of a diameter of 25 or 30 mm., closed at one end, suitably supported, and heated almost vertically, keeping it enveloped by the flame of a large gas burner for a length of 50 to 60 mm. until the bottom of the tube and this length of tube shall have been carried to the temperature of the red without, however, melting the tube.

Meanwhile, a glass rod, one of whose extremities has been drawn out to a thread, is dipped several times in a mass of pure potassium chlorate, which has been fused in a porcelain capsule and allowed to cool until it commences to solidify. Some decigrammes of the solidified salt are collected on the end of the glass thread in an ovoid form.

When the tube is quite red, the rod is introduced, bringing the potassium chlorate within about 10 mm. of the bottom of the tube, taking care that it does not touch the tube at any point. In a few minutes, the potassium chlorate is liquefied under the influence of the radiation from the sides of the tube and the enveloping flame, and it flows slowly, drop by drop, on to the bottom of the tube, still kept at the red. Each drop explodes the instant it comes in contact with the glass, with a distinct sound, and a white smoke proceeding from the vapor of the chlorate. But the explosion is not propagated to the portion of the liquid salt remaining on the thread of the glass rod. The sound of the explosion is clear, though a little prolonged, like that of a slow powder.

The experiment is not difficult. It is the same as with the detonation of picric acid. Both take place within an inert gas. I have made it in nitrogen with picric acid.

Picric acid detonates still more readily if the operation is in the atmosphere or in oxygen, as might be expected, because the heat of the total combustion is added to that of the pyrogenous decomposition.

Potassium chlorate also detonates more readily if heated in a hydrocarbonated flame, its oxygen combining in part with the carbon and the hydrogen, causing a new disengagement of heat. This observation occurs in a recent and very interesting report of Col. Ford, Chief Inspector of Explosives in England, relative to an explosion that occurred in 1899 in a manufactory of potassium chlorate. But it is not sufficient to prove that pure potassium chlorate would be explosive by itself, without the intervention of any combustible body. The presence of the latter concurs in determining, in a manner more prompt and more easy, the explosion of the chlorate.

This is a suitable place to remark that the precise conditions I have described for the experiments with potassium chlorate and with picric acid may be realized in a great fire, affecting the roof or the walls of a storehouse containing a considerable quantity of either of these substances. The case referred to above is in point. It was the explosion of 156 tons of potassium chlorate in the factory of the Kurtz Chemical Works of the United Chemical Company, Limited, in the Borough of Saint Helena, London. Five men were killed, forty or fifty wounded, and buildings of considerable size destroyed. The conditions I have described were realized on a large scale. The chlorate

was packed in wooden casks, an additional circumstance facilitating the explosion, the burning casks acting, as, in the experiments, the flame of a combustible gas.

Examples, somewhat intermediate, may also be cited, of the exaltation of explosive properties produced by similar circumstances. Such is the case with dynamite. Spread on a table in a thin layer, it burns almost without danger. But it is otherwise if a considerable mass is ignited, especially if heated with the concurrence of a previous wadding, even without a detonator.

These phenomena are not dissimilar to the detonation of acetylene, which does not take place by simple heating under atmospheric pressure in the open air, but occurs as soon as the condensation of the gas, under double or higher pressure, allows the temperature developed by the decomposition to reach a point where—without being lowered by mixture, convection, conductibility, or radiation—it will rise still higher.

In such a case, the temperature increasing without its increase being limited by dissociation or change of physical state, the velocity of the reaction, combination, or decomposition, varies according to a law which I have recognized as an exponential function of the temperature. There are certain general properties of explosive bodies, which come into play with unequal facility, according to their individual nature. It is important that this fact should not be ignored in their industrial or military employment.—The above is translated from the French of M. Berthelot, in the Annales de Chimie et de Physique.

FIG. 1.—BLOCK OF STEEL 10 INCHES IN THICKNESS PARTIALLY MELTED BY LIQUID IRON.

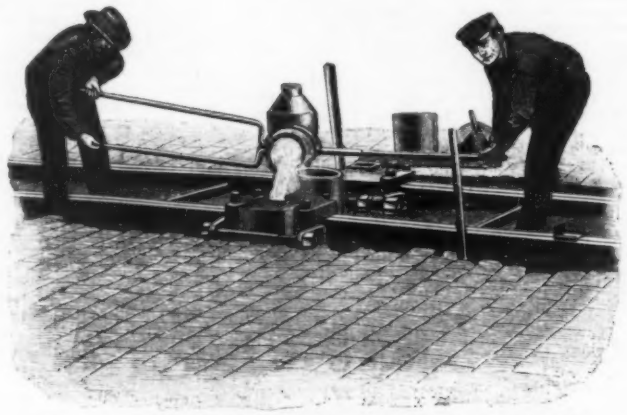


FIG. 2.—OPERATION OF SOLDERING RAILS BY THE GOLDSCHMIDT PROCESS.

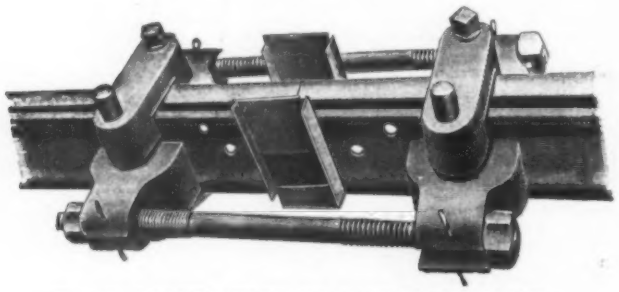


FIG. 3.—CLAMPS USED IN SOLDERING RAILS.

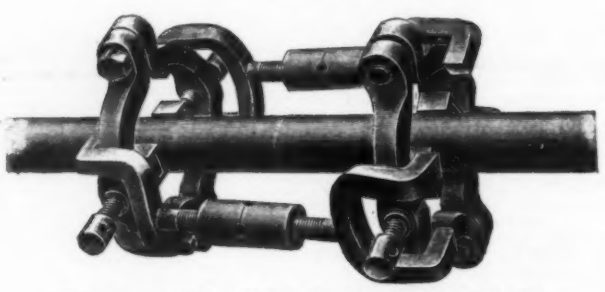


FIG. 4.—CLAMPS USED IN SOLDERING PIPES.

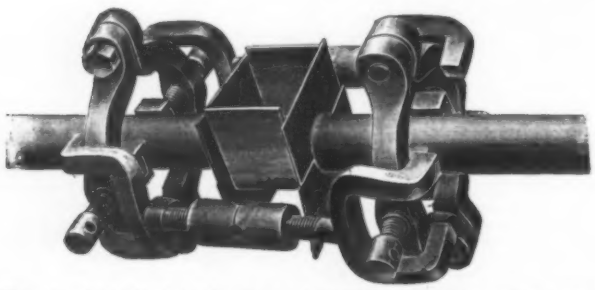


FIG. 5.—IRON PLATE BOX FORMED AROUND THE JOINTS.

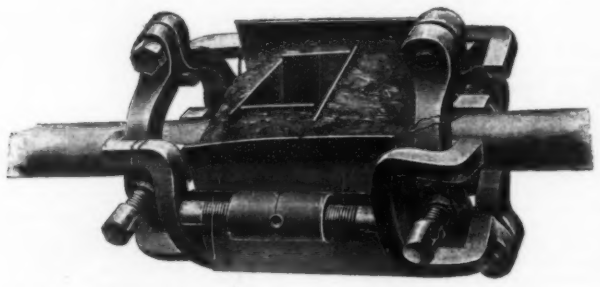


FIG. 6.—JOINT OF PIPES READY FOR SOLDERING.

THE METALLURGIC USES OF ALUMINIUM.

FOR some time past there has been a good deal of talk about some quasi-marvelous discoveries made by Dr. Hans Goldschmidt, of Essen-am-Ruhr, in regard to certain chemical properties of aluminium and of the numerous industrial applications of which they are susceptible.

However eulogistic are the terms in which this inventor has been mentioned, they are not at all exaggerated, since the practical results of his recent labors are already revolutionizing metallurgy, and do not yet appear to be at the end of their conquests.

It is a question of the utilization of the chemical reaction of aluminium upon certain metallic oxides at a high temperature, either for obtaining in a free state certain metals difficult of isolation, or for the production of a great calorific power.

The idea of causing aluminium to react upon metallic oxides in order to bring about their reduction is not new, but the management of the reaction devised by Dr. Goldschmidt is absolutely original and makes of a laboratory operation but recently dangerous an industrial process that is nearly harmless and of extensive application.

It would take too long to mention here all the scientists who, since Deville and his fellow laborers, the Tassier brothers, studied the reducing properties of aluminium upon the oxides, sulphides, chlorides and other metallic salts.

Among the labors that directly inspired Dr. Goldschmidt's researches may be mentioned those of Claude Vautin relatively to the action of aluminium upon the metallic sulphides, which led this chemist to the discovery of his mode of operation. He was probably also influenced by Moissan's experiments upon the production of alloys of aluminium by the addition of metallic oxides to a bath of molten aluminium, by those of Kupelweiser and Matignon upon the determination of the calorific effect of certain reductions of aluminium, by the researches of Helouis upon the reduction of vanadium, by those of Dubois and Gauthier upon the reduction of boron and silicium, and, finally, by the industrial preparation of phosphorus devised by Franck. Completing the work of his predecessors, he has endeavored to domesticate, so to speak, the energy manifested in so violent a manner in the reaction that takes place in a crucible raised to a red heat. It was left to him to demonstrate the uselessness of a preliminary heating of the crucible, a process that rendered the operation dangerous, inasmuch as the energy developed sometimes causes a genuine explosion.

It was in 1895 that the inventor first made known a process of reducing metallic oxides and sulphides through aluminium. He had then no intention of indicating an industrial method and of popularizing it, but rather the idea of introducing into metallurgy a laboratory process common to a large number of metals for the commercial and economic production of the rarest of them. Thus, he mentions the oxides or sulphides of chromium, iron, tungsten, molybdenum, nickel, cobalt, uranium, vanadium and glucinium as capable of being reduced with profit through aluminium. The presence of iron among these rare metals ought not to astonish us, since it is a question here of iron free from any trace of carbon; and how impossible it is to obtain this metal in ordinary metallurgic practice is well known.

The reduction is effected in a crucible of refractory clay, or of magnesium, which better resists the intense heat developed in the reaction. The salt to be reduced is mixed, before fusion, with magnesium finely divided or in a pulverized state, the mixture being made in the theoretical proportions defined by the chemical equation, say for chromium:

$$Cr^2O^3 + Al^2 = Al^2O^3 + Cr^2.$$

The inventor insists upon the importance of the intimacy of the previously prepared mixture. It is the essential and characteristic condition of his process. If one is content, in fact, to cause the oxides to react upon aluminium in pieces, or simply molten, the latter is oxidized superficially and becomes immediately enveloped with a pellicle of aluminium that will arrest the operation at the very beginning if precautions be not taken. It is, moreover, to guard against such inconvenience that Dr. Goldschmidt recommends the use of a flux, in the case of oxides, with a view to increasing the fusibility of the scoriæ.

Since aluminium has a great affinity for metals, the inventor advises the use of a slight excess of oxygen in order to assure the complete oxidation and prevent the formation of aluminium alloys.

Such as it is, the preparation indicated already permits of obtaining chromium pure and free from carbon for the manufacture of chrome steel.

In 1897, Dr. Goldschmidt completed his work by demonstrating the uselessness of heating the bodies in presence, and also predicted all the applications of which his new method was susceptible by reason of its extreme simplicity. At the same time he generalized his process and specified that the reducing properties of aluminium are not exclusive to it, but belong to other metals, such as magnesium and its carbides.

In order to extract pure metals from their oxides, sulphides, chlorides, or other salts, they are mixed with aluminium, magnesium or their carbides in a pulverulent state, and a reaction is brought about by submitting one of the points of the mixture to the heat of a blowpipe flame or of an incandescent wire. Nothing is simpler and more practical of execution, whatever be the place in which one operates. Nevertheless, Dr. Goldschmidt has further perfected the elegance of his method by a mode of ignition based upon the very principle of the process. It consist in employing, for the production of the ignition of the mass, an additional mixture of aluminium and peroxide of barium. The reaction of these two bodies one upon the other takes place at so low a temperature that a simple match suffices for the ignition; but per contra, the mixture disengages a heat such that the principal mass in contact with it immediately enters into fusion.

Practically the operation is as follows: Into a crucible of refractory clay lined with magnesium is in the first place put a small quantity of the principal mixture, which is covered with a pinch of the igniting mixture. This latter is lighted by means of a match, and the temperature that it develops starts the oxidation. As soon as the latter has begun, the mass becomes covered with a very hot stratum of alumina, upon which the operator continues to throw the principal mixture, the reaction of which takes place instantaneously, the aluminium that it engenders forming scoriæ, while the liquid metal traverses the stratum of oxide already formed, and collects at the bottom of the crucible in the form of a metallic button. By this method, Dr. Goldschmidt prepares in his Essen works about eight pounds of pure chromium per minute. As may be seen from these figures, this metallurgic process partakes of magic by its simplicity as well as by the eminently rebellious nature of the products treated.

The fusion of the refractory oxides, particularly of

alumina, is not one of the least remarkable results of the method, and bears witness to the prodigious temperature of the mass under treatment. The brilliancy of the alumina that covers the metal is such that the eyes are unable to support the sight of it. If, for example, liquid iron freed from its scoriæ be poured upon a piece of iron or steel, it forms a passage therein by melting the metal, as may be seen in the piece of steel ten inches in thickness represented in Fig. 1, and in which the liquid iron has formed a furrow three inches in depth. By means of the Wiborgh thermophone, Dr. Goldschmidt has ascertained that the temperature of the

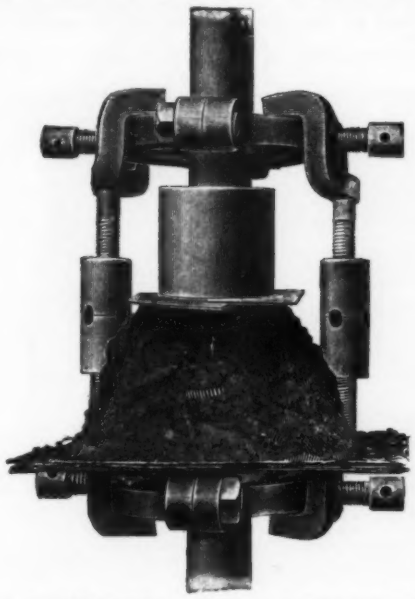


FIG. 7.—COVERING OF THE JOINT IN THE CASE OF VERTICAL PIPES.

materials in reaction, in the case of chromium, exceeds 3,000° C. Such a temperature, never before known outside of the voltaic arc, reveals a great development of energy. It is possible to obtain some idea of it by comparing the Goldschmidt crucible to the electric furnace. Now, M. Moissan, in the reduction of titanic acid by carbon, had to have recourse to 300 electric horse power. Seeing the analogous nature of the reactions, it is very evident that a like work is developed in the crucible. A calculation of the heat units disengaged would, moreover, permit of easily proving it. This similitude has caused the name of "secondary electric" or "poleless furnace" to be applied to the Goldschmidt crucible. Just as M Moissan met with great difficulty in putting such huge quantities of energy in play in the limited space offered by his electric furnace, by reason of the dangers of explosion due to the volatilization of the lime and to the violent projection from the furnace of the lime in fusion, so too the reduction of oxides or salts by aluminium would offer serious risks, especially when effected in a heated crucible. Thanks to the Goldschmidt process, which is carried on in the cold way, rapidly, and by successive additions of moderate quantities of material, the operation, even when performed on a large scale, is nearly free from danger. Through it, the calorific energy of the voltaic arc is at the present time coming into competition with a power of production contained in a latent state in aluminium. Such power, which is nothing less than the chemical affinity of this metal for oxygen, sulphur, etc., is so much the more available in that the net cost of aluminium is becoming less every day, and that alumina being one of the most common substances upon the face of the earth, there is no fear of its exhaustion. It is therefore not extraordinary to see the uses of this process rapidly multiplying.

APPLICATION OF THE PROCESS TO METALLURGY.

All the applications of which the Goldschmidt method have hitherto been susceptible have been

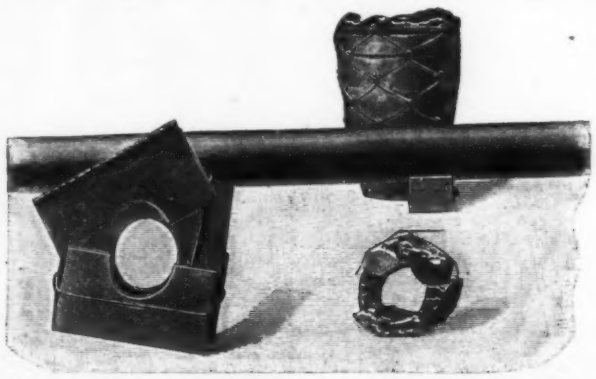


FIG. 8.—SOLDERED TUBE, CRUCIBLE, IRON PLATES, AND BUTTON OF METAL.

made by the inventor himself in his Essen works. It was to metallurgy that he applied himself in order to obtain chromium free from carbon, and manganese equally pure. Two works, that of the Société d'Electro-Chimie at Saint Jean-de-Maurienne in France, and the Chemische Thermo-Industrie of Essen, Germany, are producing these two metals in large quantities.

Pure chromium communicates to iron certain properties that the 40 and 60 per cent. ferro-chromium processes did not permit of suspecting, by reason of the large amount of carbon contained therein, say about 12 per cent. In this way are obtained soft chrome steels and steels containing a large proportion of chromium.

As for pure manganese, it does not seem that that, at least at present, is of undoubted utility in metallurgy. Its net cost, ten times that of ferro-manganese, does not, moreover, permit of its use in this industry. On the contrary, it is advantageously introduced into the alloys of copper, with which it easily associates itself without giving rise to losses. The 5 per cent. alloy of manganese possesses, it seems, so great a resistance as to cause a demand for it for the manufacture of rods and tubes.

The ferro-titaniums, with 10, 20 and 25 per cent. of titanium, prepared by the Goldschmidt method, present more interest to the metallurgist, since the incorporation of a few tenths per cent. of titanium with a steel gives the latter a fibrous character and assures it a great resistance. Ferro-vanadium also appears to be destined for a certain future in the iron industry, while ferro-boron has furnished no satisfactory results.

The possibility of introducing foreign metals, in nearly certain proportions, into baths of steel was not long ago the cause of great progress, and gave carbon steels a heavy blow through the adoption of a scientific method in the production of these essential metals. At present, science is gaining still further ground in the domain of metallurgy, since, through

FIG. 9.—SOLDERED TUBE CURVED COLD IN THE VICINITY OF THE JOINT.

the Goldschmidt process, it permits of regulating the introduction of additional metal with mathematical exactitude without modifying the quantity of carbon. In fact, the addition of a metal in a solid state to a metallic bath presents inconveniences, the solution being effected slowly, and a portion of the elements to be incorporated being burned. On the contrary, by adding to the metallic bath the quantity of the Goldschmidt mixture that corresponds to that of the metal that it is desired to introduce, a reaction is brought about in the interior of the liquid mass through the heat alone of the latter, and the metal, in a nascent state, is immediately and integrally absorbed.

Let us mention, also, the possibility of causing the penetration, into the superficial layers of an object

FIG. 11.—TRIAL BAR TAKEN FROM A SOLDERED TUBE.

still incandescent, of a certain quantity of a metal adapted for giving it special qualities. The heat of the body treated suffices in this case to bring about the reducing action. The elevation of temperature due to such reaction afterward reheats the body during the entire operation.

It must be remarked that this mode of introducing a metal into the external layers of a casting leaves a wide latitude for varying at will the quantity of the metal incorporated from one point to another of the object, and even for varying one region or another according to the nature of the additional metal.

Dr. Goldschmidt sees also the possibility, through his process, of preventing the solidification of castings or the hardening of scoriæ without the introduction, to this effect, of heterogeneous elements. This again is a great advantage in the casting of ingots of steel.

As a secondary product of a very appreciable value serving to reduce the net cost of the metals prepared by the Goldschmidt method, may be mentioned an artificial corundum, called by the inventor "corubin." This substance, which is much harder than natural corundum, is produced in reactions with the oxides and consists solely of molten alumina. Its hardness is almost equal to that of the diamond, and grindstones made of this material present remarkable qualities from the view-point of sharpening and resistance to wear.

ALUMINOTHERMY.

Despite the importance of such modes of utilization of the Goldschmidt process, they are not the ones that have attracted the most attention. Another use, long studied by the inventor, has contributed toward the popularization of his discovery, and this is the reheating or the soldering of metals by what he calls "aluminothermy. It was natural, in fact, that an endeavor should be made to put to profit the energy

FIG. 10.—SOLDERED TUBES FLATTENED BY HAMMER.

The ordinary longitudinal soldering has given way, while the Goldschmidt soldering is intact.

generated under the form of heat by the reaction. The difficulty was to render practical the handling of the materials in ignition. The question of economy evidently had to take precedence over all other considerations, and the applications had to be limited to cases in which the forge cannot be used and in which recourse is generally had either to electricity or the hydrogen blowpipe. It was thus that Dr. Goldschmidt thought it possible to effect the soldering of electric tramway rails, which is performed electrically in the United States by the Thomson-Houston Company with an installation carried by several cars and requiring 200 horse power. Thence to pass to the soldering of iron piping was but a step.

The mixture employed for such operations consists of powder of aluminium and oxide of iron. This is placed in a crucible handled by means of tongs, and is ignited in the ordinary manner. A sufficient quantity of it is prepared for the work to be effected. In order to moderate the heat that is disengaged by the reaction, and that here need not be as great as in the reduction of the metallic oxides, the iron oxide employed is extended with a proper proportion of sand, magnesia or lime. For relatively low temperatures, the use of a 50 per cent. impure aluminium extracted from bauxite is sufficient. It is, despite all, advantageous to employ, by preference to impure mixtures, quite pure ones that give higher temperatures, and less quantities of which have to be used for the same object.

If we refer to Fig. 1 and what has been said apropos of the temperature of this liquid metal, which melts the block of steel upon which it is poured with the greatest facility, we might suppose that the heating of the pieces to be soldered would be too energetic and produce a fusion thereof. But there is nothing in this, since in the experiment illustrated in Fig. 1 there was poured upon the steel, not the entire contents of the crucible, but the liquid metal freed from its scoriæ, while for soldering we first distribute the scoriæ and afterward the metal over the piece. As soon as the scoriæ come into contact with the metallic piece, they solidify into a protective crust (a bad conductor) upon which the liquid metal may be poured from the crucible without any fear of seeing the piece to be worked become soft or set in a mass with the metal.

This role of the scoriæ is important. They form a sheath that sifts the too intense heat of the liquid and prevents it from adhering to the piece operated upon.

At the inception of his experiments, Dr. Goldschmidt endeavored to solder the pieces by plunging them into the crucible, but succeeded only in melting them. It then occurred to him to utilize only the scoriæ for producing the heating, but the results were mediocre. He found that, with its great conductivity, the liquid metal preserved the greater part of the utilizable heat at the bottom of the crucible. It was not until after he had ascertained the instantaneous solidification of aluminium that the idea occurred to him to pour on the metal in fusion and that he obtained the result desired.

The operation of soldering rails has already been performed upon several lines of tramways in Essen, Brunswick, Hamburg, Berlin, Dresden, etc., and given good results. Fig. 2 shows the operation as performed at

Brunswick in May, 1900. The simplicity of the process and the slight complication of the equipment give it a great advantage over all other systems. Fig. 3 shows the arrangement employed for such operation. Two clamps that grasp the extremities of the rails to be soldered may be held in place by two bolts that unite them. Around the joint, by means of plates of iron, is formed a box designed to receive the material in fusion. This box is surrounded with sand or any other refractory product, and then the mixture is prepared in the crucible, as we have stated. The incandescent mass is then poured into the box; care being taken to distribute, in the first place, the liquid aluminium over all the metallic parts. At the end of about two minutes, the ends of the two rails are sufficiently hot to permit the soldering to be proceeded with. By reason of the high temperature developed, the soldering necessitates no forging, but is effected simply by compression of the surfaces to be soldered, one against the other. Such compression is brought about on the one hand by the bolts of the two clamps and, on the other, by the expansion of the heated pieces.

After the cooling of the metal cast around the joint, the mass is broken with a blow of a hammer, and the rails appear perfectly soldered. The same process has been applied to conduits of medium size. The clamps have a form slightly different from that shown in Figs. 4 and 6. Fig. 4 represents the clamps put in place upon pipes 2 inches in diameter. Fig. 5 shows the manner in which the box designed to receive the metallic liquid is formed. In Fig. 6 the box is seen covered externally with a refractory material, and the joint is ready for soldering.

In the case of vertical pipes, the arrangement represented in Fig. 7 is adopted. Here a plate of iron supports the refractory material that envelops the casting box.

In Fig. 8, behind the soldered tube, is shown the crucible that has been used for the operation, while in the foreground are seen the iron plate box and the mass of metal produced by the operation.

The elegance of this process may be seen from an examination of these different pieces. The instruments, which are not very complicated, consist of a crucible, clamps and plates of iron. The performance of the operation requires no skill, since it suffices to ignite the mixture prepared in advance according to formulas variable with the dimensions of the pieces to be soldered. Finally, the disengagement of the finished joint is extremely easy, as has been seen. The plates of the box also are disfounted without any difficulty and may be used several times.

Let us add that for the soldering of iron or steel there is no need of polishing the surfaces. All that is necessary is that they shall be clean and not oxidized. For copper, a scouring material and a solder must be employed as usual.

The resistance of such joints is remarkable. With steel tubes it is equal to that of the metal itself. Moreover, their tenacity may be judged of by the tubes represented in Figs. 9 and 10 and by the trial bar shown in Fig. 11, taken from the wall of a tube soldered by the Goldschmidt method. In Fig. 10 it is seen that the tubes submitted to a hammering while cold are broken along their seam, and according to different generatrices, while the Goldschmidt joint is intact.

In the trial bar in Fig. 11, in which the soldered part is clearly distinguishable, it may be seen that the rupture has occurred in the metal itself and not in the soldered part. The resistance of this specimen to rupture was 5,265 pounds to the square inch, and the elongation 11·5 per cent. In a trial piece not soldered taken from the same tube the resistance to rupture was 5,545 pounds to the square inch, and the elongation 15 per cent.

We shall not dwell upon the economical side of the method. It is of interest to remark, however, that it is not expensive, and forms a perfect joint to which the flange joint cannot be compared.

Another application of the high temperature obtained through the oxidation of aluminium is to be found in the drilling of hard steel armor plates, since it permits of a local softening of the metal and renders easy an operation that was formerly very troublesome.

Finally, Dr. Goldschmidt has seen the possibility of repairing iron or steel castings, samples of which are shown in Figs. 12 and 13. In order to obtain the results visible in these pieces, it was necessary to operate with a mixture capable of giving pure iron, and the composition of which has likewise been studied by the inventor. There is no doubt that such repairs are as resistant as the joints spoken of above. It is possible, moreover, when it is deemed useful, to give the added metal the resistance of that of the piece itself by a proper addition, in the crucible, of silicium, manganese or chromium.

The diversity of the methods of utilizing the calorific energy developed by the oxidation of aluminium proves the capital importance of Dr. Goldschmidt's discovery, and the future will probably show us still other marvels that will be due to it. However this may be, the products and results obtained by the inventor were the object of a remarkable exhibit in a show-case of the Gallery of Metallurgy, wherein were to be seen specimens of all the metals or alloys prepared at Essen, such as cobalt, chromium, manganese, nickel, 50 per cent. manganese copper, and 20 and 30 per cent. ferro-titanium, all in considerable quantity, as well as artificial corundum, or "corubin," produced by the solidification of the scoriæ of alumina. Small-sized specimens of vanadium and niobium figured alongside of the preceding. Opposite the case that contained them were shown pieces of rails of different sections soldered so perfectly that the place of the joint had to be guessed at. The trial pieces represented in Figs. 9 and 10 were also found there, along with the different instruments employed in the operation of soldering.

Let us add, in conclusion, that the Société d'Electro-Chimie, in its exhibit near the electric furnaces installed on the Champ de Mars, performed daily experiments in soldering in the presence of the visitors, who were greatly puzzled by these cyclopean operations.—For the above particulars and the accompanying engravings, we are indebted to the Revue Industrielle.

THE THOMSON-HOUSTON UNDERGROUND TROLLEY.

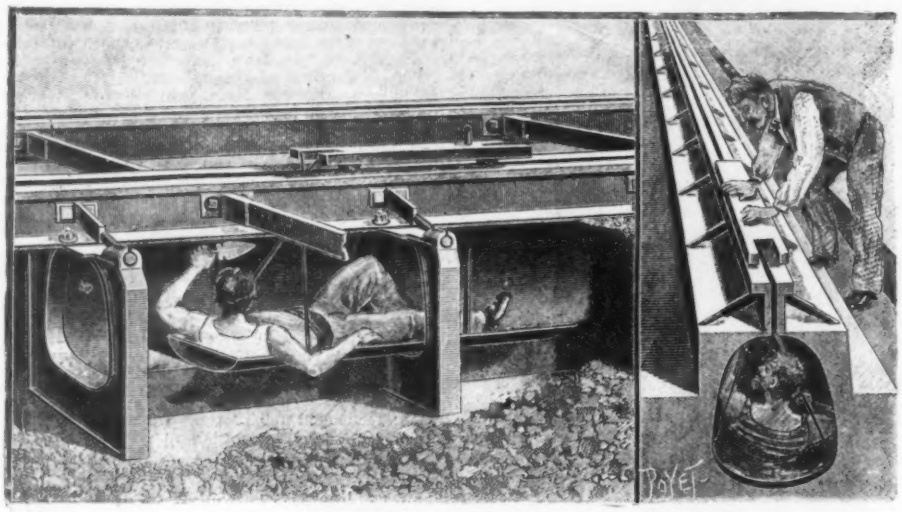
IT now appears to be well demonstrated that electric propulsion by trolley is that which is best adapted for tramways. In the majority of large cities it reigns at present as a sovereign, but, let us say at once, as a sovereign that cares little for æsthetics.

The wire that leads the current is suspended above the track, and is in most cases held at the right and left by strong cables, which are secured to the houses. All this interrupts the perspective and mars the aspect of the buildings and streets. Up to the present, what is tolerated in the rural districts, where the useful has to take precedence of the agreeable, has not been admitted in Paris; and let us hope that it will always be thus in the particular case that occupies us.

This, however, was no reason why we should have deprived ourselves of the pleasures of electric propulsion, for all that was necessary was simply to adopt the underground trolley.

The Thomson-Houston Company, which is grantee of a portion of our large lines, has accepted this condition, and has just finished an important section that has very recently been put in service between Place Pereire and Montmartre Station. In reality, this section, which connects one of the most important quarter of Paris with the Exposition, is composed of trunk lines, the first of which belongs to the one running from Porte d'Asnières to the Military School, and the second to that running from L'Etoile to Montparnasse Station. It will be seen that upon a portion of the line, between L'Etoile and the Military School, the number of the tramways will be doubled. Before long, these two lines will be completed by another extending from Montparnasse Station to the Bastille. In all, there will be 7·25 miles of tramway doing duty for the external boulevards, and eighty cars will be employed thereupon. The works that furnish the current are situated upon Rue Emeriau at Grenelle, and comprise five dynamos of 300 kilowatts each in continuous current at 500 volts. The conductor is placed along the track in a subway formed under one of the rails, which is double, in order to allow of the passage of the rod fixed to the side of the car and carrying the trolley.

The construction of this subway is very interesting.



CONSTRUCTION OF THE UNDERGROUND TROLLEY OF THE THOMSON-HOUSTON TRAMWAYS.

It is formed of iron frames cast in a piece with iron rings and spaced a yard apart. These rings present an elliptic section, of which the large axis, which is vertical, is 18 inches and the small axis 14. At the summit, at the part designed for the reception of the double rail, there is a free space for the passage of the trolley. After a certain number of frames have been placed in position in the trench, they are provided internally with plates of iron which entirely close them, and then concrete is run in so as to unite all the rings and fill up the trench. In this way there is formed a very solid continuous subway, which, so to speak, forms a single block with one of the rails of the track. Between two frames, and at every 13·75 feet, there is a manhole through which a man may pass. The first time that he enters through this is to dismount the iron plates and form the necessary joints, after the concrete has set. Since the section is very narrow (14 × 18 inches), and it would be almost impossible for him to move therein, a very simple artifice is employed. In the first place, there is introduced into the interior a plate of iron supported at the four corners by ropes that are connected with a small carriage provided with two wheels placed one in front of the other upon the double rail. The man lies upon this platform, and the laborers at the surface move him to the different points where he is to work.

After the subway is completely finished, the insulators are placed opposite each manhole, and through the latter is passed the conductor, which is afterward fixed to the insulators. The manholes are closed by a dismountable cover, so that they can be always utilized. The subway is connected at every 100 or 150 yards with the city sewers in order to assure of the outflow of rain water and such filth as may accumulate therein by passing through the slot of the double rail.—La Nature

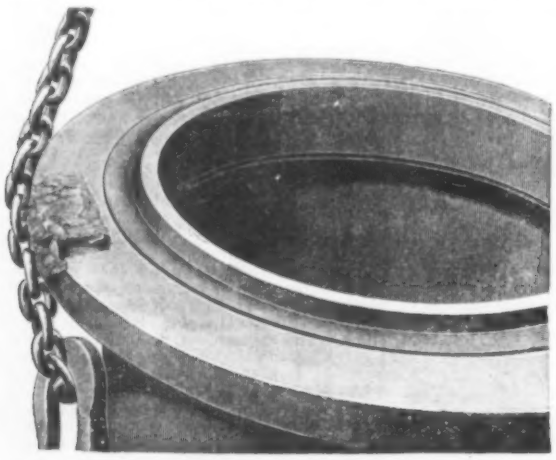


FIG. 12.—CYLINDER FLANGE REPAIRED BY THE GOLDSCHMIDT PROCESS.

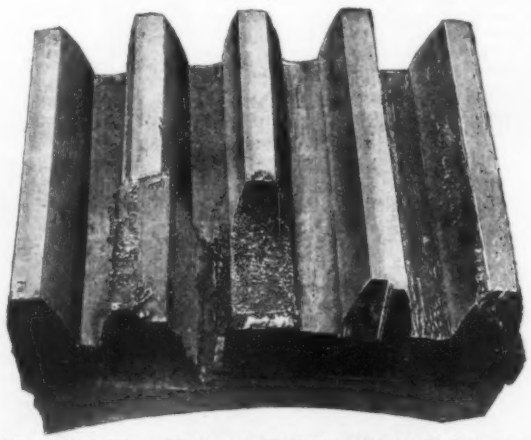


FIG. 13.—GEAR-WHEEL, TWO OF WHOSE BROKEN TEETH HAVE BEEN REPAIRED BY THE GOLDSCHMIDT PROCESS.

The Pacific mail steamer "City of Peking" has been provided with an electrical steering device connected with the ship's compass. It is so arranged that the vessel cannot deviate from her course without ringing an alarm. The inventor is now working upon a contrivance by the use of which a steamer will steer automatically after her course has once been set, says The Electrical World.

CLOCKWORK AT THE EXPOSITION OF 1900.

WATCHES, clocks, or amusing objects of clockwork, with automata or moving figures, have always been manufactured; but it was in the eighteenth century especially that the thing assumed a character of fancifulness that had never before been reached, and that certainly has never since been exceeded. In the pleasing little pieces of this epoch are combined taste, richness of material, skillfulness of execution, and freshness of coloring.

Of old, all these charming objects that are now kept in showcases were made use of.

The pieces that we are about to describe have as great an interest from a mechanical as from an artistic standpoint, and the talent expended by the clock and watch makers was equal to that of the other artists who concurred in their manufacture.

Fig. 1 represents an opera glass that was exhibited at the Centennial of Goldsmiths' Work, in class 94. It belongs to the incomparable collection of Mr. Frank Bernard. This charming object, which is about three inches in height, is entirely covered with paintings in enamel and encircled with gems. In the cylindrical part of the body of the object there is an aperture of a length equal to a third of the circumference. This cylindrical part forms a sleeve, in the interior of which revolves a second cylinder containing the entire mechanism. If the interior cylinder be actuated by means of the upper part of the opera glass, with which it is operatively connected, a dial marking the hours will appear. The object thus constitutes a small clock. If the gyratory motion be watched, a landscape wholly figured in enamel will be seen to present itself in the middle ground, before the aperture, while in the foreground rapidly passes a hunting party. We see the dogs, huntsmen, and attendants pursuing a stag. These subjects are in semi-relief. During such passage a music box placed in the interior of the piece plays a hunting air. When the cylinder is revolved again, a solid panel closes the aperture and continues the enamel decoration.

Fig. 2 represents a mouse of diminutive size belonging to the same collection as the opera glass. It is entirely of gold and adorned with fine pearls. When its tail is pulled, a clockwork movement concealed in the body is wound up. Then the animal begins to run as naturally as if it were alive.

In Fig. 3 is reproduced, from the same collection again, a pistol very richly mounted in enamel, fine pearls, and brilliants. The crown and crescent indicates that the object must have belonged to a sultan. When the flint-lock of the pistol is freed, a small bird comes out of the barrel, perches thereon, flaps its wings, moves its head, and begins to sing. After the air is finished, the bird enters the barrel again.

Fig. 4 represents a golden sugar-plum box, upon the cover of which is painted a carpenter's shop on a copper ground. The figures in the background move and act in the manner indicated by the work that they are performing. The mechanism, which is quite complicated, seeing the numerous functions of the figures, is nevertheless contained in the thickness of the cover.

Fig. 5 represents another sugar-plum box belonging to the same collection. This piece, which is wholly covered with painting upon enamel of a remarkable character, is of gold. Its cover consists of three panels that may be opened separately; under the central one is the sugar-plum box properly so called. Under one of the others is the hour and the minute dial. Finally, under the third, there is a charming mechanical subject representing a figure of Love forging an arrow in the middle of a landscape, while another blows the bellows. In the background a windmill revolves. The figures are of chased gold of different colors, and the landscape is painted upon enamel. The whole exhibits a remarkable brilliancy of coloring.

Fig. 6 gives a reproduction of a small harp about three inches in height. It is of gold enriched with enamels and precious stones. The dial is placed in the body of the instrument. Upon freeing an internal mechanism, it is possible to set in motion a music box that has the curious property of rendering sounds perfectly comparable to those of a genuine harp. This piece is of very beautiful composition and workmanship. In Fig. 9 is shown a gold watch, the bottom of which represents the interior of a kitchen. The figures and certain accessories are of gold of different colors, and the rest is painted. We see a dog revolving in his wheel, and through a mechanical transmission turning a piece of roast beef placed upon a spit in front of the fireplace. On one side, a servant is spinning, and, on the other, a jet of water seems to be flowing from a fountain. All this is true to nature.

In Fig. 8 is shown a silver knife with ornaments of gold and gems and having a clockwork movement in the handle, the dial and balance of which are visible. The clockwork mechanism is a masterpiece. It takes up the entire length of the knife, and thus necessitates a very peculiar arrangement. Moreover, as a clock, it sounds the hours as they pass. The idea of placing a timepiece in the handle of a knife dates back at least to the eighteenth century.

In the collection of M. Marmuse, at the Centennial of Cutlery, in class 93, was exhibited a knife (Fig. 7) which had two dials on one side of the handle and one on the other. Each of these had a hand that seemed to indicate the hour. This was not the case, however, for these hands constituted the secret that it was necessary to know in order to open or close the knife. The operation consisted in placing each hand upon a determinate hour, since otherwise the knife remained unchangeably open or closed. The eighteenth century knives that we find with watches in the handle evidently proceed from these primitive secret instruments.

In M. Chappay's very large collection at the Centennial of Goldsmiths' Work was exhibited a small gold lantern of the size shown in the engraving in Fig. 10. It is an elegant piece of jewelry as regards form and decoration. It has three enamel dials with three gold hands actuated by a single movement placed in the interior of the lantern. The top of the piece opens through a hinge in order to permit of winding up the movement.

The showcases of the Centennials of Goldsmiths' Work and Jewelry contained many more interesting objects of clockwork, but they were less characteristic than those just described.

The grouping of all the valuable collections that composed the centennials permitted of studies that will no longer be possible after these treasures have been returned to their owners.—M. Planchon in La Nature.

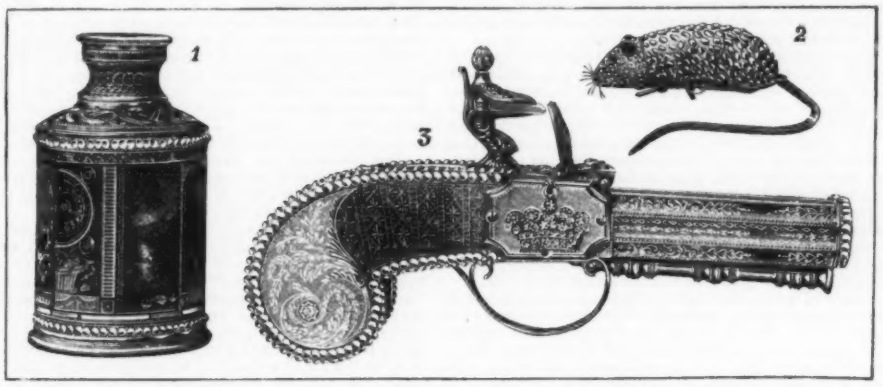
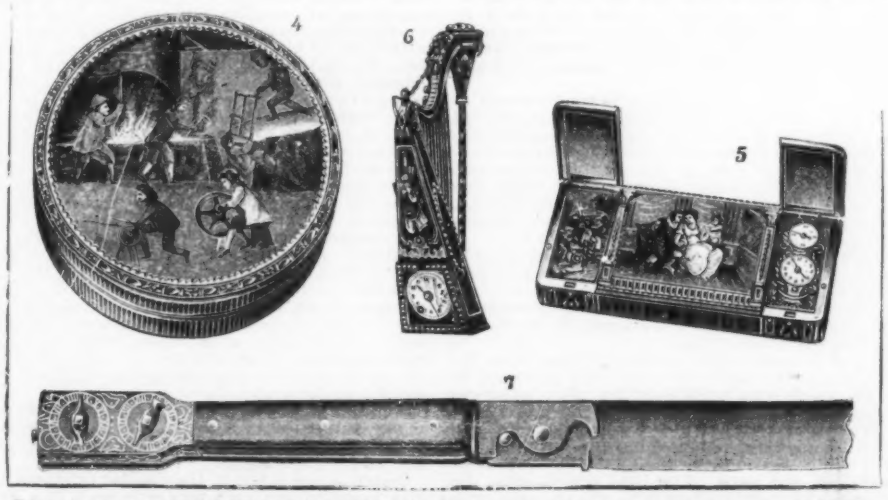


FIG. 1.—OPERA GLASS. FIG. 2.—GOLD MOUSE ORNAMENTED WITH PEARLS.
FIG. 3.—PISTOL ORNAMENTED WITH ENAMEL AND BRILLIANTS.

FIG. 8.—KNIFE OF SILVER. FIG. 9.—GOLD WATCH.
FIG. 10.—GOLD LANTERN.



FIGS. 4 AND 5.—GOLD SUGAR-PLUM BOXES. FIG. 6.—SMALL HARP. FIG. 7.—KNIFE WITH TWO DIALS.

UPPER AIR MOVEMENTS.

METEOROLOGISTS have long been convinced that a systematic study of the clouds would afford information regarding the movements of the upper air which would possess great practical as well as theoretical value, says The New York Tribune. Balloons and kites have rendered more or less service of this kind. But balloons are costly and likely to be lost, if unaccompanied, and it is almost out of the question for man to ascend higher than five or six miles, because of lack of air to breathe. And thus far it has been impracticable to send a kite up more than two or three miles. Yet cirrus clouds report on the conditions at an elevation of from six to ten miles. Influenced by that fact and other considerations, the international conference of meteorology in 1891 approved a scheme for co-operative observations of clouds for a whole year in several of the countries of the northern hemisphere. The plan was not carried into execution until 1896-97, and the report of the American observations, with an elaborate discussion by Prof. Frank H. Bigelow, has just been issued by the Weather Bureau. The task was committed to good hands, and has been admirably performed. Meteorologists cannot read the document without feeling satisfaction over the results secured and the broad, progressive way in which the facts are handled.

A uniform classification of clouds was agreed upon by the international conference. Ten types were adopted as the basis of observation. The observers were carefully instructed how to distinguish them, and a month's preliminary practice was undertaken before official records were made. The work was carried on at fifteen stations in the United States, all but one of which were east of the Rockies. At each station an instrument called a nephescope was used. This is a round mirror fixed in a horizontal position and, having the degrees of a circle and points of the compass inscribed on its edge. Through a suitably adjusted peephole the observer noted the direction of the cloud movement, and with a chronometer ascertained the apparent speed. The real velocity, though, was determined only after supplementary observations had been made with a pair of surveying instruments, to find the height of the cloud under scrutiny. Observations were made several times a day when the weather permitted.

The results of this work having been tabulated and digested, it appears that in this country, east of the Rocky Mountains, the lowermost type of cloud, the stratus, floats at an average height of 2,700 feet in winter and 3,500 feet in summer. Both in winter and summer the bases of cumulus clouds keep at a mean eleva-

tion of 3,900 feet, but the domes sometimes reach a height of 9,000 or 10,000 feet. The nimbus or storm cloud varies from 5,900 to 6,200 feet. The average height of the cirrus in summer is 33,000 feet, and in winter 31,000. But this is occasionally exceeded by three or four miles. In September, 1896, cirrus clouds were seen at an elevation of 56,000 feet, or over ten miles! Nearly every class of clouds attains a loftier altitude between the hours of 4 and 8 p. m. than at any other part of the day, whereas between noon and 4 o'clock they fall a trifle below the average.

In velocity conspicuous variations are attributable to a change of season. Stratus, for instance, floats along at a mean of thirteen miles an hour in warm weather, but accelerates its speed to twenty-four miles an hour in cold. The tops of cumuli travel thirty-four miles an hour in summer and forty-seven miles an hour in winter. The average for cirrus in the former season is sixty-seven miles and in the latter seventy-eight. But in March, 1897, the maximum velocity observed was 187 miles, while in the previous December cirrus was seen moving at a rate of over two hundred miles an hour! Nice weather to get caught in with a flying machine! Prof. Bigelow remarks that from this one year's data it looks as if the greatest speeds were realized at an elevation of seven or seven and a half miles, and that from that level up to ten miles there was a slight falling off. But further observation is required to verify that inference before it can be accepted as final.

A fact that has been brought out more clearly by these cloud studies than ever before is that the movement of the air above the nimbus level, say six thousand feet, is practically independent of the lower strata. In the region covered by these records there was a steady eastward motion at all times of the day and year, the velocity varying considerably (as already indicated) with the altitude and season. The gyratory wind systems peculiar to areas of high and low barometer gradually disappear with elevation, and then merge with the general flow. There are at times trifling southerly and northerly elements in the direction, but these nearly balance each other, and keep the average motion almost due eastward. Precise calculations, limited to observations over only a part of the United States, leave a very small excess of northward movement, but, of course, this is compensated for in some other part of the globe.

No part of Prof. Bigelow's report will attract wider attention than his consideration of the causes of areas of high and low barometric pressure. Espy, Loomis, Abbe, Ferrell and other meteorologists have argued with force that local heating from sunshine, and the liberation of heat in the center of a depression by the condensation of vapor into rain, caused the uprising of atmosphere in a storm, and the consequent lowering of the pressure. The overflow of the ascending air was thought to be largely instrumental in producing the higher pressure through a simple heaping-up process. Hann, Davis and some other modern meteorologists have lately come to discredit this theory, or at least to limit its application to ocean-born, tropical cyclones.

Bigelow, too, now rejects the notion. He holds that mechanical forces, and not thermal, are mainly responsible for the formation of depressions. He says that there is a more or less regular succession of air currents sweeping over this country, alternately from the southwest and from the northwest; and he believes that friction develops eddies between them. The late William Ferrell held that the poleward flow of hot air from the equatorial region occurred mostly at a considerable elevation. Bigelow thinks that it is now proved that very little air moves northward at any great height. Most of it keeps down close to the ground. The other current, the one from the northwest, is recognized by Ferrell, who is everywhere regarded as one of the highest authorities on atmospheric circulation that this or any other country has produced. But for his disagreement with other meteorologists Prof. Bigelow gives forcible reasons, and experts cannot fail to see that he has made out a strong case for the dynamical theory of storms. Some of his findings are scarcely less than revolutionary.

Not merely for the purpose of completing the study of the conditions existing permanently in the upper air, but also for their value in forecasting the weather from day to day, Prof. Bigelow urges that cloud observations be continued. He points out that air currents which are directly concerned in weather changes often exist at an elevation of only from 3,500 to 10,000 feet. No hint of them is afforded by the direction of the surface winds. He specifies certain situations where information of this kind would be particularly serviceable in forecasting rain. And he expresses the hope that by this means meteorology may be changed from an empirical to an exact science, and that much greater accuracy in prediction will thus be made possible.

THE PRESENT CONDITION OF THE COAL-TAR INDUSTRY.*

By H. W. JAYNE.

As the end of the century approaches it is interesting and instructive to look back and note the wonderful growth of the chemical industries and the great changes they have undergone, especially in the last few years, in which many of them have been revolutionized.

It may be of interest to some to consider the growth and present condition of one of the greatest of these, that of coal-tar and its products.

This industry, which originated in the endeavor to utilize a troublesome by-product, has grown to be one which without doubt employs more scientific men in its study and development than any other, and a description of all its products and their manufacture would be a review of the greater part of the organic chemistry of to-day.

About 1822 coal-tar was first distilled in England, but it was not until 1856, the date of the discovery of the first aniline colors, that the industry became an important one, and it is in the last twenty years only that it has attained its present gigantic proportions.

At first the entire supply of tar was derived from the distillation of coal in the manufacture of illuminating gas, but under the constantly increasing demand new sources have been developed, and these latter may in time become our main supply.

The coal-tar produced in modern gas plants is quite different from that of some years ago. Cast iron retorts were then used and the temperature of carbonization was comparatively low. The tar in consequence was generally quite fluid and contained considerable toluene, xylene and phenols, some naphthalene and free carbon. With the introduction of fire clay retorts a marked change was noted, and to-day the extreme high heat produced by the use of regenerators yields a tar which, considered from the standpoint of the distiller, is of much poorer quality.

The aim of the gas manufacturer is to get the largest amount of gas of good quality that can be obtained from the kind of coal carbonized. The high temperatures employed to do this cause the volatile products as they are evolved during the distillation to be decomposed in contact with the intensely heated sides of the retort with separation of free carbon, and, as exhausters are universally used, this is drawn out with the gases and deposited with the tar.

The higher phenols and hydrocarbons are split up with formation of large quantities of naphthalene; therefore, the tar is heavier in gravity and thicker in consistency on account of the presence of more naphthalene and carbon and less of the liquid portions.

As the use of coal-tar products became more general the demand for tar increased, and in consequence the price advanced. The supply being to a certain extent fixed, manufacturers were stimulated to look for other sources of supply. Several plants were built in Europe and one in America, having the production of tar and ammonia as their chief aim, but these were soon found to be unprofitable. Attention, however, had been called at an early date to the waste of these by-products in the manufacture of coke, and inventors without number entered the field with ovens designed to produce a good coke and at the same time save the tar and ammonia. A number of these, varying in minor details of construction, have been found to work well in practice; besides, many beehive ovens have been provided with condensing plants for collecting the by-products. The tar obtained from these latter ovens and also from the gases of blast furnaces is, however, quite different in composition from that obtained from gas works or improved coke ovens.

The temperature at which the coal is carbonized in the former being much lower, the tar contains practically no aromatic bodies, and when distilled yields oils which are free from naphthalene, benzine and phenol, but instead contains compounds of the paraffin series, large amounts of higher complex phenols and paraffin. Such tars are, therefore, of no value to the manufacturer of refined coal-tar products.

In the United States, owing to the extended use of oil and carbureted water gas, the output of coal-tar has been very much less in proportion to the population than in Europe, and it has been heretofore necessary to make up the deficiency by importing creosote oil and pitch. In the last few years, however, there has been a considerable addition to the domestic supply. A number of beehive ovens have been fitted with condensing plants and large batteries of coke ovens have been erected, and from these a fine grade of coke and considerable tar is obtained. The American coals appear to be much richer than those carbonized abroad.

In these ovens none of the charge is burnt to supply the heat necessary for the carbonization, as is the case with the older forms of ovens, and therefore the yield of coke is very much larger and may even amount to more than the analysis of the coal would seem to warrant, this being due to the deposition of carbon on the surface of the coke by the decomposition of a part of the tar as it is distilled.

The fact of a larger yield and purer quality of coke must, it seems, finally force other manufacturers to adopt improved ovens, and if even a part of the 20,000,000 tons of coke yearly produced in this country was made in such ovens with recovery of tar, we would pass from the condition of a shortage of supply to a veritable flood of tar, for even a small portion of which there would not appear to be a market.

One of the forms of ovens successfully introduced is the Semet-Solvay, of which about 400 are in operation in this country. Those interested in the subject will find a full description of them in an article by J. D. Pennock, which appeared in this journal in 1899.

The Otto-Hofmann ovens are used very extensively abroad, and through the kindness of Dr. Schniewind, chemist of the company, I am informed that 680 ovens are in operation in the United States, and that 400 are now being erected in Canada. The most interesting of these plants is that at Everett, near Boston, Mass., where 400 ovens are in successful operation. These have been fully described and illustrated by Dr. Schniewind in articles which have appeared in The Progressive Age. The plant is so situated that coal from Nova Scotia can be discharged directly from the steamers, and labor is reduced to a minimum by use of every modern appliance for handling the materials used and produced.

The gas as it distills being higher in candle power in the first hours of carbonization, this portion is collected by itself and after removal of tar and ammonia is supplied to the city of Boston and vicinity. The gas coming off in the latter part of the distillation is used, after the tar has been removed, to heat the ovens. The coke is equal in quality to the best metallurgical coke, and is sold for this purpose or broken into various sizes for domestic use.

It would seem that this novel and interesting application of the coke oven is destined to come into general use for large cities.

The tar from these ovens resembles the average retort tar, except that it does not contain as much low-boiling hydrocarbons or phenol.

A certain amount of tar is also obtained from the manufacture of oil and water gas, but these are of much less value than pure coal tar. The water-gas tar is especially difficult to utilize, as it contains from 50 to 75 per cent. of water in the state of an emulsion which will not separate on standing.

In the United States tar is usually distilled into light oil, heavy oil, and pitch. The light oil comprises the first portions of the distillate until the oil, as it runs off, sinks in water. The entire distillate when mixed has a gravity of from 0·93 to 0·98. Its nature has varied with the change in the tar as noted above; formerly they were quite fluid, but now in most cases they are semisolid from naphthalene.

The pitch remaining in the still after the distillation is known as soft pitch, and is adapted for roofing or paving purposes.

Formerly it was customary to run to hard pitch, which was sent abroad to be used in the manufacture of compressed fuel; the anthracene oil obtained by this distillation was filtered and the anthracene pressed in hydraulic presses, making 40 per cent. anthracene. This was shipped to England and used in the manufacture of alizarin. At that time anthracene was one of the most valuable of the crude tar products, but the price has now fallen so low that it does not pay to export it, and there is very little sale for hard pitch, as the manufacture of briquettes for fuel is carried on in a limited way only. The manufacture of anthracene has, therefore, been abandoned for some years.

The demand for creosote oil has, on the contrary, been constantly increasing owing to its extensive use in creosoting lumber, a number of plants for this purpose being in operation here.

Oil for this purpose is required to conform to certain specifications; formerly it was deemed necessary to have a large amount of tar acids, but now it is recognized that the naphthalene is a much more important agent in the preservation of lumber, and in consequence specifications require 40 to 50 per cent. to be present, and in cold weather the oils are often entirely solid from separated naphthalene. In this connection it is well to call attention to the fact that many specifications call for 50 per cent. of naphthalene and yet require the oil to be limpid at 90° F., which is an impossibility when such a large amount of naphthalene is present.

When we come to consider the refined products of coal-tar, we can, in the short time at our disposal, mention only the most important. In general it may be said that each year greater purity is demanded by consumers and a large number of commercial products are practically chemically pure.

This branch of the industry has not made as great strides in the United States as it should. A severe blow was dealt when nearly all the protective duties were removed a few years ago. Formerly there was on the most of them a duty of 20 per cent., which enabled the American manufacturer to compete notwithstanding the higher wages ruling here.

The use of special labor-saving machinery which has done so much to enable our manufacturers to enter the markets of the world, is not an important factor in this industry, which, owing to its nature, does not permit the extensive use of such labor-saving devices, and where machinery can be used, we find the German manufacturers, who are our chief competitors, have the most improved devices in this line.

If we compare the estimates of cost of manufacture by American and German experts, the item of labor is seen to be a very serious one. For ordinary labor we must pay from 14 to 15 cents per hour; German estimates are based on 6 to 7 cents. In the pay of skilled mechanics, the difference is even more striking. Carpenters, masons, machinists, boiler and tank makers receive from 35 to 45 cents per hour, while the prices abroad are scarcely 50 per cent. of these. This has a two-fold effect on the industry: First, in increasing the item of repairs and maintenance, which, owing to the nature of the business, is a very large one, necessitating the constant renewal of parts destroyed in the processes. Second, it handicaps the manufacturer by requiring a larger outlay of capital to erect the plant than is the case abroad. A conservative estimate would be that an average plant would cost twice as much here as in Germany.

Of all the refined products, benzene has probably been subject to the greatest fluctuations. The demand for this article increased so rapidly that the price became very high, and efforts were made in all directions to perfect processes which would produce it independently of the gas works. It was at this time that the endeavor was made both in Europe and America to distill coal in retorts at the mines with the making of benzene as their prime object; but, as already stated, these were soon abandoned. A plant was also built in Ohio to manufacture benzene and its homologues from petroleum residues, but without success.

Attention had been called at an early day to the large amount of benzene present in the coal-gas, amounting to about twenty times as much as is present in the tar from the same gas. It was manifestly impossible to remove it from the gas without destroying, to a large extent, its illuminating power, but this objection did not hold good with the gas obtained from the improved coke ovens, and appliances were added to these plants to remove this benzene. A large number of such plants are in operation abroad at this time; the gas from the ovens, after removal of tar and ammonia, is forced through specially designed towers, in which the gas is brought into intimate contact with a fraction of oil from coal-tar. This oil absorbs the benzene, and, when saturated, is heated and the crude benzene driven out. The product thus obtained is equal to about 90 per cent. benzene; that is to say, consists of about 70 per cent. benzene, 20 to 25 per cent. of toluene, and the balance of higher bodies. The introduction of these benzene extracting plants may be said to have been too successful, as the price has fallen to such an extent that the extraction at present is hardly remunerative. We are, however, assured of a source of supply which can be readily increased as the demand warrants. The present supply is undoubtedly more than the demand; toluene, however, is not obtained in such large quantities by this method, and as the demand is steadily increasing owing to many new uses, among them the manufacture of artificial indigo, the price has been advanced so that it is now selling abroad at a higher price than benzene, while formerly the reverse was the case. At the present time there is no plant in operation in this country extracting the benzene from gas.

The low price of benzene permits it to be used in many industries as a solvent for the extraction of chemicals and drugs, and immense quantities are used abroad for enriching gas.

Naphthalene is one of the coal-tar products which is now manufactured on a very large scale in a great degree of purity. This article has advanced considerably in price, owing both to the great demand and to

* Chairman's address at the annual meeting of the Philadelphia Section, American Chemical Society, May 17, 1900. (Jour. Amer. Chem. Soc.)

the fact that crude naphthalene is now readily sold without removal from the creosote oil for reasons stated above. Before the duties were removed there were three factories manufacturing the article in this country; since it has been placed on the free list, only one of these survives. The output is chiefly used as a substitute for camphor for destroying moths.

Crystal carbolic acid or phenol is one of the few tar products which has not suffered the general decline.

In all the varied new sources of supply of other tar products, none has been found which promises increased output of phenol. The coke oven tar does not appear to yield much phenol, so that while the supply is constant or perhaps increasing slightly, it does not keep pace with the large demand, the chief of which is for the manufacture of picric and salicylic acids. A limited amount of phenol is made in this country, and considerable refined from imported materials, but the great bulk comes to us in a finished condition from Europe.

Nitrobenzene, nitrotoluene, and other nitro compounds are made in one factory, the output being mainly used by manufacturers of colors and explosives. A certain quantity of rectified nitrobenzene, known as oil of myrbane, is used by manufacturers of soaps and oils.

Aniline oil, which is made in such large quantities abroad, is not made at present in this country. Its manufacture was undertaken a number of years ago by makers of colors, but abandoned, as it was found the article could be imported at less cost. A factory, however, is now being equipped for its manufacture, and in a few weeks will be in operation.

Acetanilide is made by two or three factories, and they supply nearly all the requirements of this market.

When the tariff on coal-tar products was revised and most articles placed on the free list, for some reason salicylic and benzoic acids were singled out from all other compounds and favored with the specific duty of ten cents per pound. In consequence a number of works are now producing the former acid, using imported phenol.

The finer organic compounds are apparently not produced, except vanillin, which is being made by at least two, if not three, firms.

Notwithstanding the great competition of Europe in aniline colors, the American manufacturers have, in the last few years, made decided strides, although as yet they appear to have confined themselves to the older standard colors. They are aided by a duty of 20 per cent., with practically all their raw materials free. They still labor, however, under the disadvantage of having to import a great deal of their supplies. There are at present five factories in operation.

It will be seen from this rapid review that there is still a wide field for the chemist and manufacturer in this country; and with a gradual increase in the output of crude materials, it is to be hoped and expected that in a few years we will produce a large amount of the enormous quantity of these products now imported.

England appears to have fallen out of the race in the competition for the American trade, especially in the finer coal-tar products, and Germany is now in the lead, even competing with England in the cruder preparations. To show the important position held by Germany, attention is called to the statistics compiled by the German government up to July, 1898, on which date there were twenty-five factories devoted to anilin and anilin dyes, and forty-eight establishments which made dyestuffs, carbolic acid, and other coal-tar preparations. Among the exports for 1898 were:

9,321	metric tons	alizarin.
18,712	"	" coal tar colors.
12,360	"	" aniline oil and salts.

In this latter class the exports of 1898 were nineteen times as much as in 1883.

THE EXTERMINATION OF MALARIA-BREEDING MOSQUITOES BY PETROLEUM AND DRAINAGE.

By HENRY CLAY WEEKS.

A CURRENT monthly publication whose character, resources and circulation place it in the highest rank, has an article composed of the predictions of "the most learned and conservative minds in America" as to what will be the state of affairs in their various fields of investigation in the next hundred years. Some strange, almost impossible, ideas are advanced and others that are already in process of fulfillment and therefore not so striking. To any one who has watched the course of events in the matter during the last two years it will not be surprising that this prediction is made: Insect screens will be unnecessary. Mosquitoes will have been practically exterminated. Boards of health will have destroyed all the mosquito haunts and breeding grounds, drained all stagnant pools, filled in all swamp lands and chemically treated all still-water streams.

In May, 1899, the SCIENTIFIC AMERICAN published an article by the writer on the subject, in which the ground was taken that this pest could be practically exterminated, and instanced sections where this had already been accomplished. Some thought the term extermination too strong, and, in addresses on the subject and otherwise, spoke of the "Control of the Mosquito," as if extermination lay in the realms of hope rather than possibility. Others have been writing and speaking on the subject, experimenting and urging action, until now the stronger term is generally in use and it may be fairly said that public sentiment is aroused and that the decision is that the mosquito must go. The public interest shown is well represented in the remarkable demand that has been made for the government publication known as Bulletin 25 (new series), United States Department of Agriculture, by Dr. L. O. Howard, Entomologist, and the many long press reviews of same that have appeared in the past few weeks. So great has been the demand that already a number of editions have been exhausted and still that demand continues. It is not the intention to review that publication here, for it can be had on application, but it may be said that in it Dr. Howard continues his fight against the mosquito with most telling blows. He has long advocated putting into practice the old idea that a thin film of oil in their breeding places will destroy them. This has long been known, but it is the doing it he has urged, has experimented with petroleum as being the cheapest remedy and announces the quantity that will do the work on a given breeding surface.

Some have been putting the idea into practice and have been having marked success as the Bulletin records, and others are considering the matter in a way that will bring relief to their community as well as form a practical example for the benefit of mankind.

The first instance known to the writer of municipal action on the subject was taken by city of Winchester, Virginia, and, if it be the first, that city well deserves to have this honor recorded and recognized. The success of their movement was remarkable and will encourage other troubled cities to take like action. It seems that formerly the place had not been infested, but of late years the pest had become unendurable and injurious to material interests. Dr. Howard was communicated with, and last spring an ordinance was passed by the City Council requiring that kerosene be thrown into all cesspools, rain barrels, etc., every month. No penalty was attached, but moral suasion was tried in strong force, the mayor issuing a number of proclamations during the season reminding the people of the ordinance and urging the remedy, these proclamations being left at each house by the police. In a movement of this kind there will always be the incredulous, the oppositious, and the careless, and so the ordinance was not fully observed. But even with this partial observance "mosquitoes as a nuisance did not exist there this summer." The president of the Council says he does not know of a single person who had to put up mosquito bars. It is thought that by imposing a penalty they will have exterminated the pest by another season.

An instance is well known to the writer of a gentleman who bought a magnificent historic estate of some hundreds of acres, but was informed that it would be impossible for him to remain on it during the months of July and August on account of the mosquitoes, that the practice had been for the former owners to absent themselves annually during those months. The place previously had had a reputation of producing more mosquitoes than almost any other part in a large section. But having given some attention to the mosquito question and believing in the petroleum remedy, he took steps to alter the conditions. All receptacles for rain water were abolished, drains were kept free, pools were opened out where they could be, or, if not, sprayed with oil. This petrolizing extended to a pond a short distance from his property, but which belonged to others whose consent to treat it was given. From an inspection made it is safe to say that this pond was the largest cause of former troubles, but during this his first season he says of the present conditions that his "place was free from mosquitoes except from four to six days in August, when a salt water variety, not bred on the place, was then present." So rare were they and so careful was his attention, that noticing one or two in his green-house, he made search and found that a small tank which had been filled with water only a few days was alive with larvæ. A thin film of oil soon destroyed them.

These recent cases of relief are among the unrecorded or less known instances, but many others are cited in the Bulletin and other publications.

As efficacious as is the petroleum remedy and, in this country, so inexpensive, yet it is only applicable to comparatively small areas, as stagnant ponds, fresh or brackish, to rain water tanks, cesspools and the like, and the purpose evidently should be to obviate these places, for constantly looking after them represents an expense and a careful supervision by those whose study of the subject quickly enables them to detect the dangers from old sources as well as from new ones arising from constantly changing conditions, especially about the towns. The building of a railroad, the making of a drive, the blocking of an outlet to water by the washings of a storm or the filling in of some excavated materials, the building of a new house whose waste water is not properly cared for, these and a hundred others are exigencies which require an interest in the subject and a careful and minute watchfulness. When it is considered that a barrel of rain water left standing a few days without proper care will be the breeding place, as have been counted, of from fifteen to twenty thousand larvæ which in a short time will be developed into mosquitoes, and they in turn in a few days begin reproduction, and that in a season from six to twelve broods, depending upon the temperature and other conditions, are produced, the necessity of thorough work is evident. And yet, as the writer has stated elsewhere, if the well-known remedies against mosquitoes were as carefully used as are the preventives against smallpox, these evils would be equally scarce.

And the ultimate intention as to the larger breeding places, such as marshes, inland or tidal, should be to permanently destroy the breeding conditions in them by their thorough drainage, as can be done in most situations. By as much as marshes are the larger and more pestiferous sources of trouble, by so much is their reclamation the more important work—though all sources must be considered to make the work complete.

But there are difficulties in the drainage of marshes, especially tidal marshes, and until a community is thoroughly awake to their danger from the breeding of malaria-bearing mosquitoes, probably little will be done. If the worse than lost human energy in a section affected by malaria could be converted into action in getting rid of the causes, pestilential marshes would shortly disappear and all life would be more the worth living. But the very depression which comes from this far-reaching disease seems to make the effort the more impossible. Even the commercial idea, which governs so strongly in this vigorous nation, does not seem to be sufficient to materialize into action in many cases; the most notable one being that of the section about Newark, N. J., where for very many years relief action has been urged and shown to be advantageous by the State geologists and engineers, and where no general work is yet done. For there are very few marshes that, if properly drained, would not produce a large return on the investment, to say nothing of the sanitary and economic aspects of the case.

There are many causes which militate against reclaiming marshes, which must be done before the largest factor in the spread of mosquitoes is eliminated. Generally they are held in small tracts by a number of owners, and the more the owners, the more the difficulty of action. This fact suggests the necessity of every State having, as some places have, drainage laws that would relieve such a situation. And that leads to the statement of the necessity of some legislation preventing a small interest in a tide stream, owned by a few, and used but little, overriding the general interest and preventing a drainage scheme that would improve the health and material interests of a large territory as well as relieve it of mosquitoes. In passing—how often does it occur that a train load of passengers is held up by an open bridge over a little stream, and the cause of it all, a sailor standing on his rights and unconcernedly waiting for the tide or wind to bear his little craft through the draw. Such things are contrary to the spirit of the age, and should be remedied.

Another difficulty is found in the fact that owners, as a rule, are not informed of the financial side of the case, and they are unwilling, sometimes unable, to invest in a plan for reclamation that will mean an outlay to them, when there is already an income in the salt hay produced, though generally this is of no net profit.

There is, too, a great lack of information on the general subject of the reclamation of marshes, and their producing value is little understood. All know, of course, in a general way, of the notable instance in the case of Holland; but that nearly a million acres have been rescued from the sea under the greatest difficulties and expense in that land, and have been made to pay on the investment, is not fully realized. And the same may be said on this continent in the upper and middle Atlantic seaboard as well as on the Pacific side. Many marshes are of alluvial formation, and there are numerous instances of the continuous production of enormous crops of almost every kind for scores of years without the use of any fertilizers. Cases exist, however, of persons being unwilling to be convinced, and continuing their opposition even after a successful reclamation, as are seen in the official records of Massachusetts, where examinations by the State have shown a great improvement in the sanitary and agricultural conditions. In the instance of Green Harbor, in that State, it is shown that the death rate of the reclaimed district averages lower than the general death rate of the State, that there is a steady increase in summer visitors, and that many houses are being built. The testimony of persons of wide knowledge and ample experience in the science and art of agriculture is adduced showing the good results in that field, and yet it fails to silence opposers. Besides mentioning the remarkably heavy crops of hay, much preferred by his horses to the best from the uplands, also the excellent crops of strawberries and vegetables raised in these lands, one such qualified observer gives his experience as to asparagus in such convincing words that they are quoted in full: "While visiting the Marshfield Meadows on April 19, 1897, I found asparagus already up, very nearly high enough to cut. I was surprised at this, for my own asparagus has but just appeared above the surface of the ground, although growing on land so warm that I am usually first to ship native asparagus to Boston market. I was also surprised at the size of the stalks, they being much larger than the first set of stalks that appear on my land. When I consider the fact that the land on which this asparagus was growing has produced large crops every year for twenty years, without fertilizers of any kind, and still produces better crops than my land, which has had $660 worth of fertilizers to the acre applied to it during the last twenty years, it convinces me that this land, for garden purposes, surpasses any which I have ever examined. . . . We realize, in a measure, the great value of the material which nature has for ages been storing up for man's future use, if he be wise enough to avail himself of it."

It has been too frequently thought that to throw up an embankment to keep out the waters, and to build sluices and gates to let the interior water out, were all that is requisite; and, under this mistaken view, many instances have occurred greatly to the loss of the persons interested, and to the prejudice of the whole subject. An eminent engineer has said of reclamation: "What at first sight seems a mere mud and water proposition really requires, for its proper economic development, the best product of the latest practice in several fields of engineering and other sciences. Although the method of reclamation is centuries old, it may now be worked out by the aid of much that is novel in methods of construction and operation."

Successful reclamation requires a most careful consideration of all the conditions existing, which generally vary in some features at every point, and not the least of the difficulties to be met, and one which to-day accounts for many expensive failures, is the ravages of the musk rat, and yet even he can be circumvented with proper care. Unsuccessful reclamations can all be accounted for by the neglect of some important point. A partially drained marsh is, no doubt, in a worse sanitary condition—more pestiferous and pestilential—than if not drained at all, and for most crops it is likewise a failure. Besides, the soils in all marshes are not suited to the raising of crops, and one reclaiming failure, even on that account, seems to offset many successful ones. Care must be had in allowing for the subsidence of the marsh which occurs in more or less degree, depending upon the character of the soil. Usually, where the marsh level is sufficiently above mean low tide, reclamation can be effected without the use of artificial means to care for the inner water.

The cost of maintaining effective reclamation is slight if thoroughly done in the first instance, but, on the other hand, becomes expensive and discouraging, and there are many fields once successfully reclaimed but now overflowed from the attempt at saving a few dollars per acre in the original work.

While it may be argued as against reclamation that there is plenty of cheap land without spending good money to obtain more acreage, yet this is not the way to dispose of the fact that these marshes are the prolific breeding ground of mosquitoes, and that mosquitoes—how many kinds is not ascertained—bear the germs of a disease that, in its great prevalency, does more to reduce the vigor, which is largely the capital, of a nation than any other disease.

There is no question but that the attention which

this pest has been receiving in the last two years is the result of the settled theory of the spread of malaria by the bite of the mosquito. This discovery has been pronounced the greatest of recent discoveries, and is classed, and justly so, with that of Lister, and, as has been said, may not improbably lead to a great revolution. The Bulletin refers to the history of this theory, and explains how the one species now positively known to be dangerous, anopheles, may be detected.

A late interesting confirmation of this theory, one among a great number, is recorded of three batches of anopheles which were fed upon three separate malaria patients in Rome, and were then carefully protected in cages and forwarded to London. A victim for the experiment, who had not been in a malarious country since his childhood, volunteered, and was bitten every second day for a number of times. The subject remained in perfect health until the poison had taken its course, when all the symptoms of malaria set in, and an examination of the blood revealed the parasites of malaria.

Another confirmatory incident must suffice. The penal island of Asinaria in the Mediterranean, belonging to Italy, was chosen as being isolated and its colony under control—a state of affairs unique and peculiarly suited and carefully employed to make a decisive experiment. As usual, during last year, many primary cases of malaria had occurred, about half of the hundred cases being of that character. There were a number of ponds on the island, about half of which were perennial. These the experimenters caused to be petrolized regularly twice a month this last summer, with the result that mosquitoes disappeared, and not one primary case of malaria occurred in the colony. The Italians have given most helpful work in this matter, doubtless urged by the fact that a very large proportion of their people are malarials, and these particular scientists "expect to be able to present the first example of an entire section being freed from malaria by the destruction of the malaria-breeding mosquitoes infesting it and by the protection of the inhabitants against their infecting bites."

Other well authenticated instances are frequently given in the press of all civilization. The whole subject is resolved into this question: What is to be done for relief?

Individual and community effort is the pioneer work, and hence the work of the hour; but what is wanted, and it is not difficult to foresee will eventually occur, is that the extermination of the mosquitoes shall be a public work, as would be, and by right ought to be, the fighting of a great plague in the land.

NEW APPARATUS FOR TESTING MATERIALS IN THE LABORATORY OF PURDUE UNIVERSITY.*

By WILLIAM KENDRICK HATT, Associate Professor of Applied Mechanics, and W. P. TURNER, Instructor in Machine Shop.

AN ordinary foundry rattler of size approximating the standard is commonly used by engineers in conducting rattler tests for paving brick. Such a machine is hardly in keeping with the more perfect apparatus of a testing laboratory. The requirements demand a rattler which, in addition to presenting a good appearance, shall be easily operated, and, for the protection of the other testing apparatus, keep the air of the laboratory free from dust. Such a rattler was designed and built in the machine shop of Purdue University, as shown in Fig. 1, and has a place in the laboratory for testing materials. Subsequently a similar machine was constructed for Columbia University, New York, and advantage was taken of the experience with the first rattler to improve certain details. The photograph

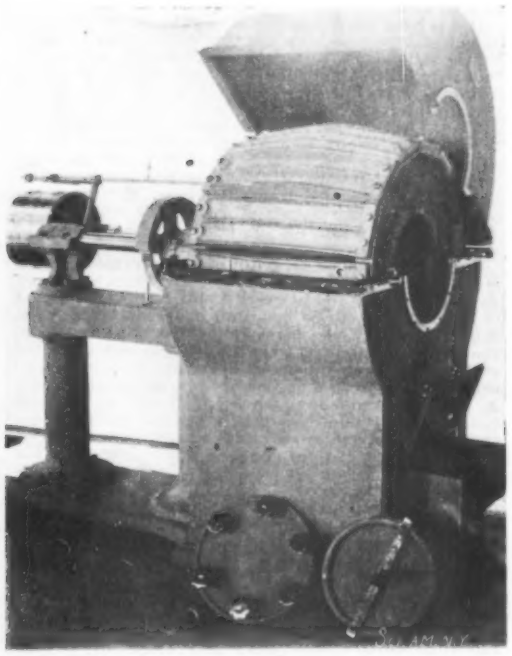


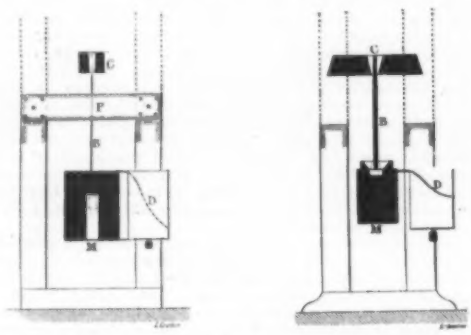
FIG. 1.—IMPROVED RATTLER FOR TESTING PAVING-BRICK.

reproduced is of the improved machine. The drum is 20 inches long and 28 inches in diameter. There are fourteen cast iron staves, with ¼-inch openings between. There is excessive wear on the staves, which should be built of steel.

The drum is overhung and is supported by bolting one head to a 14-inch cast iron face plate, which is secured to a 3½-inch shaft. The other head of the drum is thus freed, and an opening is provided therein for charging or removing the bricks, which process demands, in case of the ordinary rattler, the removal of a stave. The arrangement thus saves time, and allows the repeated weighings during the test, which are necessary in scientific experiments. In case small shot are used as a filling material, the opening in the head is closed by a plate.

The main shaft is supported on two bearings, resting on a heavy cast iron box yoke, which is supported on two cast iron columns joined together by a heavy cast iron base. The main shaft is driven from a parallel shaft by a gearing in the ratio of 4 to 1. On this parallel shaft are tight and loose pulleys, 12 inches in diameter, carrying a 4-inch belt.

As a protection from dust the drum is closely surrounded by a sheet iron casing with felt-packed joints. This casing is made in two sections, the lower part resting on the cast iron base of the machine; the upper part is hinged to the lower, and can be turned back when it is necessary to inspect or repair the bar-



FIGS. 2 AND 3.—DIAGRAMS ILLUSTRATING PRINCIPLE OF IMPACT MACHINE.

rel. A circular opening in the case corresponds to the opening in the head of the drum, and a plate quickly clamped by hand covers the opening in the case. A door in the lower part of the case provides for the withdrawal of a pan in which the dust from the rattler is collected.

The machine complete weighs about 1,800 pounds, and costs about $200, material and labor included.

AN APPARATUS FOR EXPERIMENTATION IN IMPACT.

A series of tests has been in progress in the laboratory for the past three years to determine the behavior of iron and steel under impact in tension. A temporary wooden apparatus was used for this purpose. The method of testing seemed so promising that a permanent apparatus has been designed and built of iron, with the mechanical details arranged for ease and accuracy of operation.

The principle of action of the apparatus is shown in Figs. 2 and 3. The specimen (of steel, or other metal, to be tested in tension) is fastened by wedges between

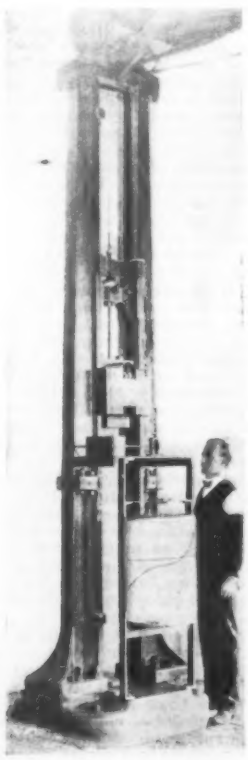


FIG. 4.—PURDUE UNIVERSITY IMPACT MACHINE.

a movable upper head or yoke, *C*, and a lower yoke to which is attached the hammer, *M*. The system of hammer, specimen, and upper yoke is lifted to any desired height, and then released. In the consequent descent, the upper yoke, *C*, is stopped by the columns of the machine, while the hammer moves on and ruptures the specimen. The energy of motion taken out of the hammer while working against the resistance of the specimen to be ruptured is known by measuring the velocity of the hammer just before impact and its velocity just after the specimen is ruptured. These velocities are calculated from the record made on the surface of a revolving drum, *D*, by a pencil attached to the hammer. The speed of the drum is known from the curve of a vibrating tuning fork imposed thereon. Then the work of deformation required to rupture the

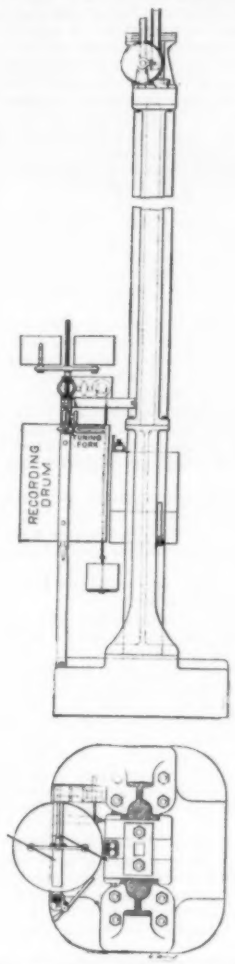


FIG. 5.—ELEVATION AND PLAN OF IMPACT MACHINE.

specimen equals the kinetic energy taken out of the hammer plus the product of the weight of the hammer into the elongation of the specimen. Part of this energy taken from the hammer does not go into the specimen, but is used in deforming other parts of the machine, such as upper head, column, etc. A close estimate can be made of the amount, and corresponding correction made.

The machine was designed to deliver a blow of about 5,000 foot-pounds. In ordinary use it ruptures a specimen of soft steel ½ inch in diameter and 8 inches between heads at one blow in $\frac{1}{100}$ of a second.

Fig. 4 shows the machine complete as it stands in the testing laboratory. Its base is partly sunk below the level of the floor and rests upon a brick foundation 5 feet by 5 feet by 6 feet deep laid in natural cement on undisturbed gravel foundation; the upper four courses are of paving brick laid in Portland cement. A ¾-inch bearing bed of 1:1 Portland cement

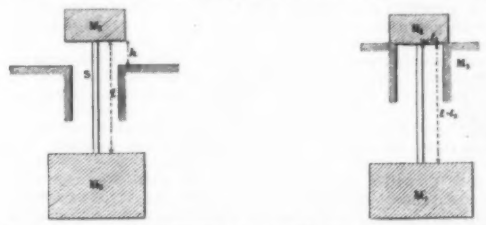


FIG. 6.—TWO MASSES, M_1 AND M_2, CONNECTED BY ROD, *S*, AND FALLING THROUGH THE HEIGHT, *h*.

mortar is disposed between the bed plate and the pier. By reference to the drawing, Fig. 5, it will be seen that the machine consists of a solid cast-iron base, weighing about 5,000 pounds, which supports two cast columns about 12 feet high, these columns being tied at the top with a cast box yoke. The inner face of each column is planed flat, and acts as a guide for the hammer. Each column includes two parts, which are bolted and doweled together, the lower part being a solid casting 550 pounds, while the upper part is cored to a U-shaped section 525 pounds.

The upper yoke consists of a heavy steel casting* (65 pounds), with its ends planed to fit inside the U-shaped column or guide. In the center is a tapered rectangular opening into which the specimen is fastened by means of wedges. Provision can be made for fastening by using threads and nuts on the ends of the specimen.

The lower yoke by which the hammer is hung to the specimen is also a steel casting, with tapered rectangular opening. This is bolted to the hammer with two

*Abstract of a paper presented before International Congress for Unification of Tests of Materials, held at Paris, July, 1900.

* This upper head reveals no trace of rupture or cracking after use in breaking 120 test pieces.

heavy bolts, which are screwed up to an initial tension.

The hammer is a casting weighing 515¼ pounds, nicely fitted to the guides with little play, and at the same time little friction. A dove-tailed slot is planed in the bottom, into which may be keyed heads of different shapes for making compressional or transverse tests.

For raising or lowering the hammer, hoisting mechanism is used, so designed that the weight may be raised, lowered, or stopped in any place desired. This is accomplished by a worm wheel keyed to the shaft which carries the hoisting drum. On the worm shaft are two friction pulleys running in opposite directions. These friction pulleys are operated by a rocker arm connected to a vertical operating shaft passing along one column. Springs hold this shaft and the friction pulley in mid-position, the lever being pulled down or up when it is desired to raise or lower the hammer.

For releasing the specimen and hammer from any given height of drop, a special tripping head is used. This head is hooked to the wire hoisting rope and slides freely between the guides. A bail suspending the upper head, to which the specimen is fixed, carries a hook maintained by a spring to bear on a square pin in the tripping head. When thus engaged, the system may be hoisted until the head comes in contact with the stop, which has been adjusted at the desired height on the guides; whereupon the stop will press down the trigger in the tripping head, disengaging the hook, and releasing the system.

The circumstances of each impact are recorded upon a revolving drum by a pencil attached to the hammer. The drum is of rolled sheet metal, supported vertically in an adjustable frame, which may be raised or lowered to the proper height for recording tests of long or short specimens. Ball bearings are used on the lower end of the drum shaft to reduce friction as much as possible. A 50-pound weight attached to clockwork furnishes the power for revolving the drum. When used, the weight is wound to a certain height, and as it falls, the speed of the drum is accelerated until the weight strikes a stop. The speed of the drum remains practically constant during the impact. By varying the height to which the clock weight is wound, the speed of the drum may be varied and nicely regulated.

The exact speed of the drum at the time of the drop is known by allowing a tuning fork with a fine brass point attached to one arm to record its vibration on a piece of metallic paper attached to the upper part of the drum.

The recording pencil is operated by an electromagnet, so arranged that as the hammer falls, electric contact is made after the pencil point has passed below the upper edge of the drum. The magnet then draws up an armature and presses the pencil against the drum.

When it is desired to make tests on long specimens, the upper yoke must be blocked up. This may be accomplished by setting solid rectangular pieces on the lower sections of the columns, thus filling the lower part of the U-shaped columns. These pieces are held in place by bolts.

The machine is easily operated, and tests may be quickly made. In making a test, the operator first fastens the specimen between the hammer and the upper yoke. If wedges are used, they are forced into the lower yoke with a pinch-bar and driven into the upper head with a sledge. By this procedure, any noticeable slip of the wedges with reference to the yoke and any slip of the specimen in the wedges is prevented. The tripping head is then lowered and hooked on to the yoke. A datum line representing the original length of specimen is drawn on the drum. The system is then raised nearly to the point of release at the desired height. The clock weight is then wound to the proper height to give the desired speed to the drum. At the instant the clock weight reaches its stop, the system is raised to find release. At the same time the tuning fork is brought against the drum to trace its record.

To absorb the shock of the hammer upon the base after rupture of the specimen, blocks of pine wood are placed thereon. The operation of placing the specimen in place and bringing about rupture is accomplished in six minutes. The time of rupture for the specimens is $\frac{1}{100}$ second.

The machine is at present used in an investigation of the effect of temperature on the resistance of materials under shock. Measurements have been made on soft steel and nickel steel from —100° F. to +400° F. Shock tests on concrete blocks are also in progress.

This resistance under shock is measured by the energy of the blow required to rupture the specimen. For any given material it is expressed in so many foot pounds per cubic inch.

Results obtained so far indicate that this resistance in case of soft steel is, at ordinary temperatures, the same whether the specimen be broken slowly in an ordinary testing machine or in impact.

This resistance under impact varies with the temperature of the bar. At —100° F., 80° F., and +400° F. it is in proportion, respectively, to the numbers ½, 1, ¾.

The resistance within the elastic limit at low temperatures does not, however, suffer any diminution. Low temperatures convert a soft steel into a harder and more elastic steel as far as mechanical properties are concerned.

This means that so long as shocks under service conditions on connecting rods, etc., do not exceed those for which the rod was designed, then the rod is stronger at low temperatures to resist these shocks.

Should a necessity arise, however, to take up unusual shocks, as in the case of accidents, then the rod or material will be weaker.*

TURBINES AT THE PARIS EXPOSITION.

QUITE a large number of turbines is exhibited in the Champ de Mars. They are so scattered about the various parts of the buildings that any general view of the turbine exhibition as a whole would be particularly difficult, and would run the special risk of being unfair by omission and overlooking machines possibly very deserving of notice. It is interesting to note that American turbine makers are practically unrepresented; Swiss, French and Hungarian firms having it all their own way. This seems to indicate that turbine manufacture in Switzerland has been organized and systematized on so economical a basis that the American firms, whose enterprise is well known, find the European market to be out of their reach.

Escher, Wyss & Company, of Zurich, is an important Swiss exhibitor of turbines. These are on horizontal axes, one of 600 horse power being a single and another of 2,500 horse power being a double-balanced machine. Fig. 1 is a general view of the former. The most interesting feature in the construction lies in the hydraulic relay governor used by the firm. The principle of this mechanism is similar—but not identical—with that already mentioned as being used by Ganz & Company, of Budapesth, but the construction is very different.

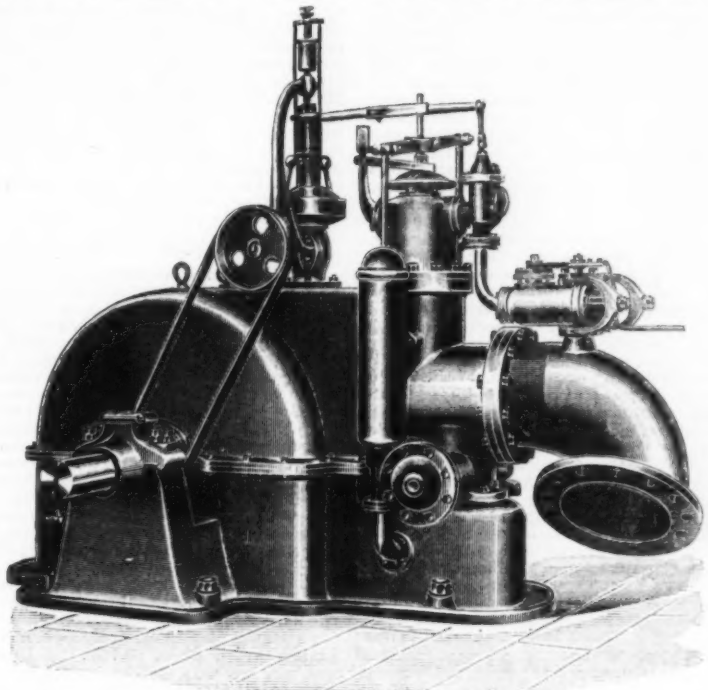
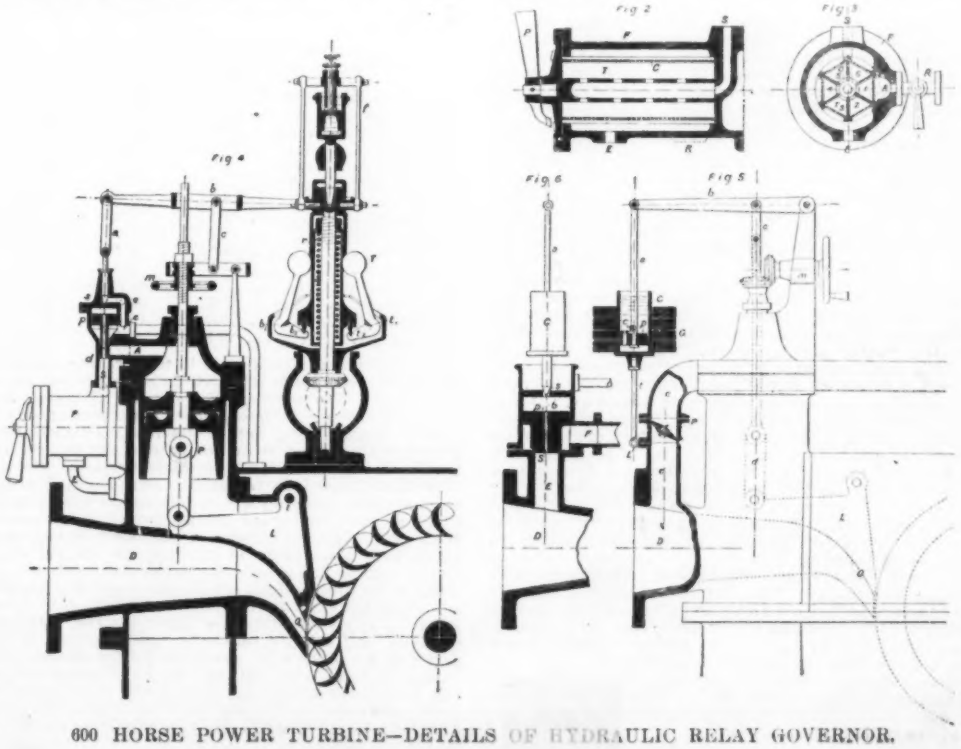


FIG. 1.—600 HORSE POWER TURBINE.

We illustrate it here in Figs. 2 to 6. In order to avoid injury to the valves of the apparatus, all the high pressure water entering it is first passed through a "revolving" filter, shown in its two main sections in Figs. 2 and 3. The water enters the cylindric casing, *F*, by the port, *E*. Inside *F* there is mounted upon a hollow perforated spindle the hexagonal drum, *T*, whose surface consists of six flat perforated sheets, *C*, *C*. This drum is divided into six chambers by longitudinal radial ribs. The water passes inward through five of the perforated walls of the drum and through the perforations of the central spindle, along the hollow center of this spindle, and out by the port, *S*, to the valve chamber of the hydraulic governor relay. Stones, coarse sand, straw, etc., are deposited outside the drum. In each position of this drum one of its faces stands opposite the recess, *A*, which is in communication with the blow-out cock, *R*. To clean out the filter this cock is opened. Filtered water then passes outward through the perforated plate opposite *A*, thoroughly washing this plate of all deposit, which escapes by the blow-out cock. By means of the handle, *P*, each of the six perforated plates is brought in succession opposite *A*, and cleaned out in the same manner. A few seconds only are needed to wash all the six perforated walls in this manner.

In Fig. 4 this filter is seen in place and is marked *F*. The headrace water in *D* has admission through small ports to the space underneath the relay piston, *P*, and thence finds its way by *E* to the filter. From the filter it passes by the port, *S*, to the underside of the small piston valve, *d*. The large relay piston, *P*, whose under surface is always exposed to head-race pressure, is linked to the curved guide blade, *L*, hinged at *l* in such manner that when *P* is raised the entrance port *o* to the buckets of the turbine wheel is partially closed. The centrifugal pressure of the head-race on the curved face of *L* tends to open this port, *o*. When the small piston valve, *d*, is raised, the full head-race pressure gains admission by the passage, *A*, to the upper side of *P*; and *P* thus being in equilibrium, *L* is thrown back to its stops so as to give full port opening and maximum horse power in the turbine. If the passage, *A*, is closed by *d* at both bottom and top edges, then *P* is held motionless, and the admission to the turbine buckets remains steady.

The small piston valve, *d*, is cast in one with the larger piston, *p*, lying above it in a cylinder bored to fit *p* without appreciable leakage. The two are bored centrally with a small passage from bottom to top. This passage admits full pressure to the upper side of *p* when the plug valve, *s*, is closed; but when this is full open, the water from the top of *p* escapes by the passage, *e e*, to the space underneath *p*, and through a drain pipe to the tail-race. When *s* is full open, therefore, *p* is in equilibrium, and the high pressure on the under face of *d* lifts *d*, leading, as above explained, to full port opening, *o*, to the buckets. This happens when the bails, *T*, of the speed governor are close in, the speed being low; and the right-hand end of the lever, *b*, being then depressed and the link, *a*, raised. As the governor speed rises, *a* is lowered; and the valve, *s*, being more and more closed, the escape by *e* becomes more and more throttled, and a greater and greater excess of pressure on the top of *p* over that on its under face



600 HORSE POWER TURBINE—DETAILS OF HYDRAULIC RELAY GOVERNOR.

* The last six paragraphs comprise additional information supplied by the authors for the SCIENTIFIC AMERICAN SUPPLEMENT.

is generated. When this excess of downward pressure on *p* balances the upward high pressure on the lower face of *d*, there is no longer any tendency toward either rise or fall of *d*; but when the governor speed goes above this critical point, the greater throttling of the escape by *s* produces downward motion of *d*. The upper ege of *d* now opens the passage, *A*, to the drain pipe, *s*, thereby taking off pressure from top of the large piston, *P*. The area of this and its leverage on *L*, round the hinge, *l*, are so designed that when *A* is in communication with the discharge to the tail-race, the pressure on the under side of *P* overcomes the centrifugal pressure on the curved face of *L*, so that this is drawn round its hinge right-handedly, and the port, *o*, to the buckets is more or less closed. As the relay piston, *P*, rises, it raises the lever, *b*, by link, *c*, thus raising also *a* and the plug valve, *s*, and stopping the action caused by the descent of *s*. The hydraulic action is evidently a sensitive one requiring nice adjustment. This adjustment is furnished by the screw and hand wheel, *m*, by which the exact position of *s* when *L* is full open against its stops can be regulated. The wheel, *m*, also serves as means of hand regulation, independent of governor, when this is desired. The speed governor is arranged for high speed. Its centripetal force is furnished by a long and strong central coil spring, *r*. The ball crank arms hinge upon hardened steel knife edge bearings, t_1 t_1, and the crank ends thrust upward upon the sleeve by knife-edge links, t_2 t_2. These arrangements practically eliminate frictional insensitiveness, and as the work the governor has to do is only to raise and lower the very small plug valve, *s*, the whole forms a very delicate governing apparatus. *f* is an oil dash pot to steady irregular oscillations of the governor and hinder it from hunting.

When the head-race pressure is very high in a high-speed turbine, the quick closing of the port area to the buckets produces hammer blows throughout the supply pipe and its appendages, which may easily cause breakage if not softened by one or other means. Figs. 5 and 6 show two modifications of Escher, Wyss & Company's plan of effecting this softening of such dangerous shocks. By this plan they escape the need of diminishing in any degree the quickness of action of the governor upon the regulating guide blades of the turbine. The principle is to open temporarily a by-pass discharging to the tail-race when the port to the buckets is closed, and to make the degree of opening of the one proportional to the closing of the other. The opening of the by-pass is momentary only, it being closed by cataract action as soon as the danger of shock has passed.

Fig. 5 should be looked upon as diagrammatic only. It represents a mechanism that may be, and is, combined with that of Fig. 4, and is not a substitute for that of Fig. 4, as it appears to be.

When the guide-blade, *L*, closes the port, *o*, it lifts the lever, *b*, and link, *a*, of Fig. 5. This lifts the bucket, *p*, of the cataract cylinder, *C*. During this lift the flap-valve, *c*, in the bucket remains closed, and oil can pass only very slowly through the small hole pierced in *c*. Therefore, the cylinder, *C*, lifts along with the bucket, and by means of the rod, *t*, it opens the butterfly by-pass, *P*, permitting water to discharge from the head-race, *D*, by the passage, *e e*, to the tail-race. The cylinder, *C*, is weighted to the proper amount by the weights, *G*, and therefore it descends slowly by cataract action, the oil flowing from upper to under side of the bucket through the small hole in *c*. This descent of the cylinder, *C*, re-closes the by-pass, *P*. On the other hand, if *L* moves so as to open *o*, the bucket, *p*, descends freely by the opening of the flap-valve, *c*, giving free way for the passage of oil from under to upper side of bucket.

For high pressure a butterfly valve, such as *p*, Fig. 5, is insufficiently tight. In this case the arrangement of Fig. 6 is adopted, in which a heavy mushroom valve takes its place. This mushroom valve is not moved positively by the lever, *b*, but is lifted by hydraulic action operating in a manner practically identical with that described already in connection with Fig. 4.—The Engineer (London).

THE MENACE OF THE BARBER SHOP.

IN some respects New York is the slowest of American larger cities, says The Medical Record. Improvements, advances, and reforms are to be noted in many smaller communities long before the necessities of the case have sufficiently impressed themselves upon the minds of our city fathers. Though the Empire City may be late in making beneficial changes, it has usually so far benefited by the experience, and often the mistakes, of other places, so that, when improvements are inaugurated, they are up to date. New York has been backward in "barber shop hygiene," which The Medical Record has advocated for a number of years. Paris has continued in the praiseworthy reforms started several years ago, and now only metal combs are allowed, and, so far as it is possible, all instruments have to be made of metal, or some substance which can be readily sterilized along with the towels, while the operator himself is expected to keep his hands reasonably clean. Pennsylvania is to be congratulated upon starting a movement in the proper direction, to secure an improvement in the conditions surrounding the barber and his work. The State Board of Health has circulated a series of recommendations, which, if followed, would vastly decrease the chances of spread of contagious disease in this way. Doing away with sponges and powder puffs, not using on one customer after another the same piece of alum to stop bleeding, and taking care in the use of cosmetics not to let them serve as media of transmitting disease from one person to another, are all wise suggestions.

Last month Missouri made a stand for scientific and sterile barbering. A board of examiners will see to it that the barber is qualified, among other things, to give a clean shave.

Canada is following in the footsteps of France, Austria, and Germany. The province of Quebec requires the barber, first of all, to be himself a healthy subject, free from transmissible affections. Then he must pass an examination in disinfection, and promise to apply his knowledge for the benefit of his patrons.

In connection with this important subject it is interesting to learn that Huebener, of Breslau, found pyogenic microbes in the beards of physicians eleven times in twenty-six examinations.

Flügge found that in a bearded subject there was a marked increase in the number of colonies when the beard was left uncovered near agar culture plates.

It is not, however, necessary for us to go into the minutiæ of scientific refinement in order to convince the thinking of the necessity for some regulation of the barber's business. In the October number of The Journal of Cutaneous and Genito-Urinary Diseases is a report on favus in which we read: "The two children now presented by Dr. Allen were American born, and they exhibited much the same appearances as the girl shown at the previous meeting. Another point was that these boys had never had medical treatment, but had been treated regularly by a barber, the applications being made in his shop. The speaker said that one of the worst cases of favus that he had ever seen in this country had been treated in a barber shop." Would it not be well for us at least to attempt to regulate the practice of medicine and surgery by the barbers of this city, compelling them to confine themselves to non-contagious diseases? For the present it would seem superfluous to tell them that Sabrazès gives in the October number of the Journal des Maladies Cutanées a practical method of perfect sterilization for brushes, combs, razors, etc., without injuring them. Three grammes of paraform tablets per cubic meter of space are evaporated in a closed space at a temperature of 40° C., the instruments being exposed for four hours, which has been found to rid them entirely of all microbes.

DRINKS OF THE WORLD.

THE interesting memorandum periodically prepared by the Board of Trade to show the production and consumption of alcoholic beverages in different countries, is gradually being made more complete, and consequently more valuable. The most recent return, issued a few days ago, is the third in succession, and it contains a good deal more information than the previous ones, particularly in regard to the British colonies. The statistics of production are much more complete than those of consumption, which are still too imperfect to allow summary comparisons to be drawn between the drinking capacity of one nation and that of another, though many suggestive facts bearing on this question are embodied in the tables. Wine, beer, and spirits are separately dealt with, and the compilers have wisely abstained from attempting to reduce them to a common alcoholic denominator, after the fallacious manner adopted by teetotal statisticians to suit a foregone conclusion. Beer is, in some respects, the most interesting item of the three, and the one about which the most definite general statements can be made. It is a striking fact, in every European country here mentioned, except Italy, and in the United States, there has been a steady and, in most cases, a large increase both in the production and in the consumption of beer during the fourteen years covered by the return. The following table shows the production in round numbers for each country in the three years 1885, 1891, and 1898:

PRODUCTION IN MILLIONS OF GALLONS.

	1885.	1891.	1898.
United Kingdom	993	1,160	1,302
German Empire	932	1,162	1,460
Austrian Empire	289	323	454
Russia	77	82	115
France	176	182	210
United States	494	811	968
Norway	7	9	10
Sweden	20	32	49
Denmark	..	41 (1892)	51
Belgium	206	236	301
Switzerland	19	30	46
Italy	3½	3½	2½

Germany, it will be observed, has outstripped the United Kingdom as a beer producer, while Austria has increased still more rapidly, and the United States have almost doubled their very considerable output. The greatest increase of all, however, is seen in those two model little countries, Sweden and Switzerland, which have both more than doubled their beer production in the space of fourteen years. The figures for consumption show that this remarkable advance is not due merely to growth of population, but to a rising taste for beer:

CONSUMPTION PER HEAD IN GALLONS.

	1885.	1891.	1898.
United Kingdom	27·1	30·2	31·9
Bavaria	46·0	48·4	56·4
Wurtemberg	33·2	38·0	43·1
Baden	17·4	21·8	36·4
Alsace-Lorraine	11·0	14·1	16·7
Austrian Empire	7·3	7·5	9·9
Russia	0·73	0·7	0·89
France	4·6	4·6	5·5
United States	8·8	12·7	13·0
Norway	3·8	4·8	4·8
Sweden	4·5	6·0	10·8
Denmark	..	17·9 (1892)	20·8
Belgium	35·6	39·2	45·5
Switzerland	7·0	10·6	15·4
Italy	0·18	0·18	0·11

The increase is general, and in some cases very rapid. The United Kingdom is beaten in actual consumption by Bavaria, Wurtemberg, Baden, and Belgium, and in rate of increase by many other countries. Some of these, though a long way in the rear, are coming up very quickly. Beer is evidently conquering the Old World, though Russia is, characteristically, yielding very slowly, and Italy not at all. Spain and Portugal are not given, but they are in very much the same position as Italy in regard to the habits of the people. Wine-producing countries are obviously less likely to adopt beer than those in which spirits are the staple drink, because the people can make their own wine at home at an infinitesimal cost, whereas spirits are everywhere dearer than beer. The United States—on the whole, a spirit country—are following the European example, and rapidly taking to malt liquor. It is a pity that no returns are available for the consumption of beer in Prussia and Saxony, as the omission of these two important kingdoms renders the comparison between the German Empire and the United Kingdom unsatisfactory. The former is credited in the return with only 27·1 gallons a head, but, in view of the very high figures for Bavaria, Wurtemberg, and Baden, no one acquainted with the country will be disposed to accept an average which implies comparatively great moderation on the part of Prussians and Saxons. There is clearly something wrong here.

FIGURES FOR SPIRITS AND WINE.

With regard to spirits—the most important item from the point of view of revenue and, perhaps, also of health—no uniform movement can be discerned. The annual consumption appears to fluctuate capriciously, except in Denmark and Hungary, where it remains very steady and very high. Denmark, indeed, is easily at the top of the tree with over three gallons a head, and Hungary comes next with about 2½ gallons; Austria follows with a steady 2·3. Then France and Belgium run each other close, having sometimes a little over and sometimes a little under 2 gallons a head to their credit; but, on the whole, the Belgians dispose of more distilled waters than the French. Their tendency, however, is to diminish the dose, while their neighbors are moving in the opposite direction, having risen half a gallon since 1886. In Germany and Holland, which fall but little short of France and Belgium, the downward tendency is more decided. They have dropped in recent years from over 2 gallons to 1·85 and 1·80 respectively. Sweden, coming next in order of precedence, can boast of no such improvement. In spite of rural prohibition and urban Gothenburgism, the consumption of brännvin—which is identical with public-house "Scotch whisky," except for the color—has been steadily rising since 1892. At one time reduced to 1·4, it has gone up again to 1·8 gallons a head. Little Switzerland is irregular, but, on the whole, more abstemious than Sweden. Each of the foregoing countries, comprising the whole of central Europe and all the north, except Norway and Russia, drinks far more spirits than we do, even to double and treble the quantity. Our consumption fluctuates irregularly within narrow limits; but it may be taken roughly as about 1 gallon a head, with some tendency to increase. Russia stood considerably higher some years ago, but has now dropped pretty nearly to our level, according to the returns, which are, however, admittedly imperfect. It is difficult to believe that 1·08 gallons a head really represents the annual consumption of vodka, which is the staple drink of the masses in Russia. In the United States the amount consumed used to be distinctly higher than in the United Kingdom, but latterly it has been a little lower. The abstemious countries are Portugal, Italy, Spain, and Norway, the two latter with about half a gallon a head, the former with much less. Portugal bears off the palm, having less than one-tenth of a gallon to its credit.

The consumption of wine is comparatively insignificant outside those countries which produce it, and even in some of them the amount per head is small. France is the greatest producer and consumer, the annual yield varying from 500 to 1,000 million gallons, and the consumption from 18 to 31 gallons a head. Of late years it has been about 24½ gallons. Italy takes second place in both respects, disposing of some 20 gallons a head. Spain and Portugal follow very closely with much the same, and Switzerland makes a good fifth with 14 to 16 gallons. The rest are nowhere. The Austrian Empire, although a wine-growing country, disposes only of 2 or 3 gallons a head, and the amount is diminishing. In the German Empire the tendency is in the opposite direction, but only in one year—1896—have the people reached an average of 2 gallons. Other countries all fall below a single gallon. Neither the United Kingdom nor the United States reach even half a gallon. If the different beverages are put together, it appears that France, Belgium, Holland, Denmark, Germany, and Switzerland all dispose of more alcohol per head than we do. And our colonies are still more temperate. Natal is the most abstemious of them all, and may indeed be considered a model country, with the following remarkably low record of annual consumption per head in gallons: Beer, 0·40; spirits, 0·60; wine, 0·08. Western Australia is easily first at the other end of the scale, with the following figures for 1897: Beer, 25·3; spirits, 2·1; wine, 1·1. It would be interesting to know why western Australia consumes so much more than other colonies. Victoria comes next with: Beer, 12·7; spirits, 0·84; wine, 1·4. Canada is very abstemious, consuming only 3·5 gallons of beer, 0·75 gallon of spirits, and 0·08 gallon of wine. It will be news to many people that the Cape produces and consumes far more wine than any other colony, but the amount of beer drunk there is very low—only 1·6 gallons a head.

CUTTING STRUCTURAL IRON BY MEANS OF THE ELECTRIC ARC.

By J. R. CRAVATH, in American Electrician.

IT is now coming to be recognized—in Chicago at least—that under certain conditions the electric arc affords the cheapest and most convenient method of cutting structural iron work or vault steel. In the reconstruction or alteration of modern office buildings it sometimes happens that some of the steel girders forming the frame of the building must be cut to accommodate the necessary changes, and likewise the changes sometimes made in bank safety deposit vaults necessitate the cutting of the vault linings. Often the girders are in a place difficult to get at with saw or drill, and the cutting through of modern vault walls can only be done by annealing a spot and then drilling it, and so on "ad nauseam" to the man doing the job and the people waiting for him to finish it. Under either of the conditions just mentioned the electric arc demonstrated itself by far the quickest, most convenient and economical method if current is available.

A year and a half ago six 18-inch I-beams in the New York Life building, Chicago, were burned off in one-tenth of the time that would have been required to saw them, the saving in time required to finish the job being one of the main objects of the contractors for the alterations in the building. The expense was also less than for sawing. Recently six 14-inch I-beams were burned off in a similar way in the Rookery at Chicago. Numerous jobs of electric burning to accommodate new vault doors and get at broken locks have also been done.

To do successful burning on structural steel a cur-

rent of not less than 350 amperes should be used, though smaller currents will do the work, only more slowly. Vault steel is more fluid when melted, and does not clog as does structural steel. The carbon with which the arc is drawn is best about 1½ inches in diameter and is, of course, connected to the negative side of the circuit. A heavy aluminium band bolted around the carbon has been found to be the best method of attaching the conductor cable; to this band a wooden handle is attached. For resistance to steady the arc a sufficient length of No. 18 German silver wire to absorb all but 70 or 80 volts, at the required rate of current flow, wound on a wood frame and put in a pail of running water, is a cheap and convenient method, and the one usually employed.

When connecting up to do such work it must always be remembered that since the positive side is connected to the structure to be worked on, the insulation resistance to ground of the source of supply should be investigated and any grounds on the negative side of the supply circuit must be removed. When drawing from an Edison three-wire central station supply (in which case the neutral is usually grounded intentionally or otherwise), the work should be done between the neutral and negative wires. To protect the eyes of the operator, a sheet-iron box over the arc, heavily lined with asbestos, and having an insulated hole for the carbon, is generally used. Where it cannot be used, as in corners, a large sheet of thick asbestos board with a hole through it for the carbon is substituted. The operator should always wear double dark glasses, and if he observes the simple precaution of never looking directly at the arc, there is no danger whatever. If he does look at the arc for anything more than the briefest interval, he may be tolerably sure of a pair of very painful eyes the following night, even though he may feel no ill effects immediately afterward. The cutting down by the arc is, of course, exceedingly rough and jagged, but for the purposes mentioned that is a small drawback compared with the saving in time and labor.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Tariff Legislation and Commercial Treaties in Germany.—The winter session of the German Reichstag, which began on Wednesday, November 14, is recognized as the beginning of what will be perhaps the most important legislative campaign that has taken place since the formation of the empire. Besides the discussion of the policy of the government in respect to its interests in China, it is expected that there will be introduced sooner or later during the coming year not only a new schedule of important duties, but the correlative and not less important question whether the several commercial treaties with other nations, which will expire by limitation at the close of 1903, shall be re-enacted with such modifications as experience may suggest or abandoned at the demand of the extreme protectionists, headed and controlled by the Agrarian party.

That German industries and commerce have been powerfully favored and supported by the influence of these treaties, and that the past eight years have done more than any other period of equal duration to raise Germany to a place in the front rank of manufacturing and commercial nations, are facts which no one ventures to dispute. The complaint of the Agrarians is that the benefits of this liberal policy have inured wholly to the advantage of the industrial and mercantile classes, while the farmers, left to struggle against increasing competition of food products from countries favored with cheaper and more fertile lands, have been sacrificed to the point of impending ruin. The controversy is one which reaches down to the foundations of German progress and prosperity, and has divided public opinion into two opposing camps, which have entered into the campaign with extraordinary spirit and determination.

An interesting incident of this contest has been the organization during the past week of a powerful national association for the support of the policy of commercial treaties, with all that it involves. This association, entitled "Der Handelsvertrags-Verein," was founded at a meeting held at the Berlin Chamber of Commerce on Sunday last, at which were present three hundred of the foremost manufacturers, merchants, and bankers of Germany. The meeting was opened with an address by Dr. George von Siemens, who declared the purpose of the proposed union to be the maintenance of a fiscal system based upon a continuation of the present commercial treaties and resistance to all measures which oppose that policy.

It was further proposed and agreed that the association should be headed by a permanent committee of not less than thirty members, representing every industrial and commercial interest, the committee having power to increase its membership as circumstances may dictate. The duration of the organization was fixed provisionally at three years, and each member then present signed a compact to pay during that period a fixed annual contribution for the support of the society and the furtherance of its work. The association is to be wholly independent of political affiliations; recruits from all political groups and parties are to be welcomed. The list of charter members of this organization includes many of the ablest and most influential men of this country—men whose prominence is not the accident of birth or inheritance, but whose energy and intelligence have contributed largely to make industrial and commercial Germany what it is to-day. Their organization cannot fail to exercise an important influence in the legislative contest which is about to open.

From an outside standpoint, one of the most striking features of the meeting was the clear and definite statement made by one of the speakers of the grounds upon which the Agrarian opposition to the renewal of the commercial treaties is based. It was shown that the wealth of the German people is estimated at 150,000,000,000 marks ($35,700,000,000), of which only 25,000,000,000 marks ($5,950,000,000), or about 16 per cent., represents the value of lands adapted to the cultivation of cereals, the owners of which are directly interested in the increase of duties on foreign grain. The question is therefore whether, in view of the present enormous development of German manufactures and the increasing difficulty of finding markets for products in face of the powerful competition of certain foreign countries, it will be wise or safe to change the fiscal policy of the empire and, by abolishing the treaties and increasing the duties on food materials, incur the danger of reprisals and tariff wars in which Germany would be at a fatal disadvantage. An interesting side light has been thrown upon this question by the award during the past few days of several important foreign contract for steel and iron to American firms, under circumstances which emphasized the potency of cheap and rapid production in the United States. The large contract for structural material placed by the North German Lloyd Steamship Company in the United States; the sale of 12,000 tons of rails by a Pittsburg firm to the Colonial Ministry of Holland: the contract for 3,400 tons of cast-iron water pipes for Soerabaya, given to a Philadelphia firm which had underbid by 25 per cent. the Friedrich Wilhelm Foundry Company, at Mühlheim, in Westphalia; the large orders placed in Maryland for railway supplies for South Africa; and finally the capture by an American firm of a contract for 8,000 tons of steel rails for a local road in Friesland, where the Krupp Works had hitherto enjoyed a practical monopoly of such supplies—all these incidents have produced a profound impression here and strengthened the spirit of resistance to any governmental policy which may, by increasing the cost of food, weaken the power of Germany to meet the new competition from beyond the sea.

Seldom, if ever, in the legislative history of any nation has a tariff measure been prepared with more thorough, careful, and comprehensive study than the one that will be submitted to the German Parliament. Its preparation has enlisted the long and painstaking labor of expert economists who represent every department and special interest of manufacture, agriculture, finance, and commerce.

The study of this subject and the preparation of statistics and material for information of the Reichstag began several years ago. Before the treaties whose fate is now to be decided had run half their prescribed span of years, the question was raised, What shall succeed them? A permanent association of business men was formed for the special purpose of acting as a bureau of information for the government on this complicated subject. Its labors have been arduous and unremitting and have served to bring out and emphasize the conflicting demands of each individual interest, and thereby show how complicated and difficult will be the task of harmonizing them and formulating a new fiscal policy that, without too rudely sacrificing the agriculturists who had so long been the mainstay of the government, shall conserve and strengthen the industries and commerce which constitute the strength and prosperity of the Germany of to-day.—Frank H. Mason, Consul-General at Berlin.

French Annexations in the Pacific.—Consul Doty writes from Tahiti, October 1, 1900, that on the 25th of August the islands of Kumter and Kimatara were annexed by France. These islands, he adds, were placed under the French protectorate in March, 1889, and are of small commercial importance.

Exports of Wood from Victoria.—Consul-General Bray, of Melbourne, under date of October 22, 1900, says:

A contract has been placed in Victoria by the War Department of England for 2,000 tons of firewood for the use of troops in China. This quantity is the first that has been ordered from Victoria, but already several large consignments amounting, it is believed, to from 4,000 tons to 5,0000 tons have been dispatched from New South Wales. The 2,000 tons are to be shipped in about two weeks, and another consignment of 1,000 tons is to follow several weeks afterward.

Annexation of Pacific Islands by New Zealand.—Consul-General Bray sends from Melbourne, October 4, 1900, articles taken from The Melbourne Argus regarding the extension of the boundaries of the colony of New Zealand and annexation of the Cook and Savage groups of islands, and indicating the contemplated action of the government of New Zealand in establishing a self-government in the Fiji Islands, when, as is anticipated, there will be an effort made by New Zealand to annex the Fijis. This move on the part of the government of New Zealand in attempting to annex the Fiji Islands, says Mr. Bray, is being opposed by the other colonies, and especially by the citizens of Sydney, New South Wales, who fear, in the event of the annexation by New Zealand, that the tariffs would greatly retard the commerce now existing between the colonies and Fiji. The articles read, in part:

In the house of representatives, the premier moved a resolution extending the boundaries of New Zealand so as to embrace the Cook group, including the islands Atiu, Mangaia, Raratonga, Aitutaki, Mitiaro, Nauke, and Hervey (Manuai); also, the following islands: the Savage group (Niue), Pukapuka (Danger), Rakaanga, Manahiki, and Penryhn (Tongareva). He contended that the colony would act wisely by assisting Fiji to obtain local self-government. In years to come, New Zealand would be a strong, self-contained nation, with colonies of her own. The arikis, or chiefs, had laid down the following conditions for the union: (1) The natives should continue the ownership of their lands; (2) the courts should be similar to the native land courts of New Zealand; (3) commissions should be appointed to define the ownership of particular areas and to decide as to the subdivision; (4) lands to be Crown granted and alienated through the Crown, the rights of owners and occupiers to be preserved and representation given in the New Zealand parliament. A danger might occur if they endeavored to annex islands at a greater distance, but the islands which he proposed to include were geographically an integral part of New Zealand.

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The motion was carried by 37 votes to 4.

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The allotment of the principal islands in the South Pacific is now complete. The first thing that strikes the eye is the preponderance of British possessions and interests. Germany, France, Holland, and the United States are also represented; but all their territories reckoned together compare insignificantly with those of England. Australia is and always must be in population, wealth, and trade the dominating power in this part of the world; but England also has New Zealand, Tasmania, part of New Guinea, Fiji, Tonga, most of the Solomons, the Cook and Savage groups, and a few of the minor islands. Germany has part of New Guinea, the Bismarck Archipelago (off New Britain), the two principal islands of Samoa, one of the largest of the Solomons, and, north of the Equator, the Caroline and Marshall groups. France has New Caledonia, the Loyalty Islands, and, eastward of the Cook group, Tahiti. Holland has part of New Guinea. The United States has one of the islands of Samoa, and, north of the Equator and halfway between Samoa and California, Hawaii. And the New Hebrides are under the joint control of England and France. So there will be five European powers competing for the trade of the islands which are scattered over the South Seas.

New Zealand's apparent idea is to establish a federation which shall embrace herself, Fiji, Tonga, and the Cook and Savage groups. Originally it was hoped to include Samoa, but Germany and the United States have secured that group.

Fiji has been a Crown colony for many years. It has a trade amounting to three-quarters of a million, a population of 120,000, and has been industrially developed by the Colonial Sugar Refinery Company, which employs several thousands of Indian coolies on its plantations. The European population is desirous of coming under the rule either of the Commonwealth of Australia or of New Zealand. A movement definitely favoring the latter is now afoot in the group. Geographically, union with New Zealand has an advantage over union with Australia. Suva, the capital, is 1,140 miles distant from Auckland, 1,540 from Brisbane, 1,770 from Sydney, and 2,227 from Melbourne. The geographical advantage is still more distinctly with New Zealand in respect of the Cook and Savage groups. But the defensive advantage may be with the Commonwealth. And hitherto Australia much more than New Zealand has supplied the capital and intelligence of South Sea industrial and commercial enterprise. Tonga accepted British protection a few months ago, and, though it is unlikely that the present self-government will be disturbed for some time to come, no other European power can intervene, and, ultimately, no doubt the Tongans will throw in their lot completely with the other British islanders in the neighborhood.

The action of the New Zealand parliament last week, evidently in accord with a carefully premeditated policy on the part of the government, and which must have been sanctioned by the imperial authorities, does not, to any serious degree, extend the boundaries of British influence. The Cook Islands have enjoyed British protection, exercised latterly by New Zealand, for a dozen years, and the Savage Islands are only important on account of their geographical position. They are now brought within the political boundaries of New Zealand, and the governor of that colony is performing the necessary ceremonies of annexation. The system of administering Maori affairs will be applied to them, and they will have representation in the New Zealand parliament. Fiji is in a different position. She must first get self-government, and will then, if the scheme goes well, federate with New Zealand. The remaining British territories in the South Pacific will probably become dependencies of the Commonwealth—at least, their geographical position suggests that destiny for them.

German Sample Room in Constantinople.—Consul Schumann, of Mainz, under date of November 7, 1900, notes that the German sample room at Constantinople, to which he referred in a previous report, has now been opened. The exhibition, he says, is quite comprehensive, embracing the following list of articles: Furniture, linoleum, lead pencils, earthenware goods, clocks, musical instruments, toys, paint brushes, rubber goods of all kinds; instruments for chemists, apothecaries, and surgeons; porcelain wares, also textile goods, sewing machines, iron bedsteads, garden furniture, heating and cooking stoves (oil and gas), water pumps, ice chests, and safes.

Railway Contract in Nicaragua.—Consul Donaldson reports from Managua, November 1, 1900:

The government of Nicaragua has to-day conceded to Mr. Julio Wiest the contract for about 38 miles of railroad which is to connect the capital directly by rail with Leon and Corinto, by a road around the lake connecting at La Paz with the western division now in operation. This will avoid the delay and cost of changing freights from the cars to steamboat at Managua and from steambeat to cars again at Momotombo. The railroad is to be finished within two years and is to cost $23,000 in Nicaraguan currency per mile, which at the present rate of exchange is about $8,000 in United States gold. Although very desirous to build the Rama Railroad, connecting Lake Nicaragua with Rama River, and thus with the Atlantic navigation through Bluefields, no contract has yet been given for its construction, owing to lack of funds to assure its completion. This is a good opportunity for American capitalists desirous of investing money in foreign enterprises.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 912. December 17.—Proposed German Duty on Wheat—Nicaraguan Steamship Contract—Destroying Canceled Bonds in Salvador.

No. 913. December 18.—*The American Reputation in Trade—The Currency of Persia—Coinage of Silver in Mexico—*Asiatic Export Bureau in St. Petersburg—*Market for American Shoes in Tunis and Algiers.

No. 914. December 19.—United States Exchange in Guadeloupe—Demand for Machinery in Guadeloupe.

No. 915. December 20.—*Commercial Education in Saxony—*Fraudulent Letters from Spain—*Industrial Concerns in Germany.

No. 916. December 21.—Prevention of Hailstorms by Cannon—*Electrical Progress in Brussels—*Hints to Exporters of Paper—*Glass in Egypt.

No 917. December 22.—Railroad Progress in Ecuador—The Manavi, or Jipijapa, Hat—Business Depression in Germany—Belgian Mining Interests in Russia.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Hair Spirit.—Resorcin, 5 parts; sublimate, 0·2; castor oil, 15; spirit (96 per cent.), 200; bergamot oil and lemon oil ad libitum. Rub the scalp in the morning with th is composition.—Pharmaceutische Zeitung.

Serviettes magiques for polishing articles of metal consist of a pure wool fabric saturated with soap and tripoli, and died with a little coralline. They are produced by dissolving 4 grammes of Marseilles soap in 20 grammes of water, adding 2 grammes of tripoli and saturating a piece of cloth 70 cm. long and 10 cm. wide with it, allowing to dry.—Seifensieder Zeitung.

Universal Spirit Lacquer.—E. Campe produces an all-around spirit varnish in the following manner: To 60 grammes of bleached shellac, 60 grammes of crushed Manila copal, 60 grammes of mastic, and 15 grammes of Venetian turpentine add 1 kilo. of spirit (82 to 95 per cent.) and finally a little powdered glass; allow this to stand for 8 to 14 days with frequent shaking. Filter after adding a little boracic acid, about 1 gramme. The varnish obtained may be used for metal, wood, paper, etc. By the admixture of aniline colors soluble in alcohol, so-called brilliant varnish is obtained for lacquering bottles, sheet metal plates and capsules.—Oel- und Fettindustrie.

Waterproof Harness Composition.—

Rosin spirit	27¼ liters.
Dark mineral oil	13½ "
Paraffin scales	16·330 kilos.
Lamp black	7·940 "
Dark rosin	5·450 "
Dark sirup	5·450 "
Naphthalene black	2·500 "
Berlin blue	0·680 "
Mirbane oil	0·170 "

Melt the paraffin and the rosin, add the mineral oil and the rosin spirit, stir the sirup and the pigments into this and lastly add the mirabane oil.—Seifensieder Zeitung.

Utilization of Slag.—In Germany and Belgium an excellent cinder cement is made. The blast furnace slag is tapped into a suitable canal with running water whereby it is granulated, and the lime sulphate is decomposed into lime and hydrogen sulphide. The granulated slag is dried, mixed with its own weight of loam, and to the mixture 3½ per cent. of powdered lime is added, whereupon the whole is finely pulverized after addition of 8 per cent. of water. Brick weighing about 3½ kilos. are made of it, which are dried, baked as usual, and again powdered up. This cement consists of calcareous earth, 59·08; alumina, 6·14; iron oxide, 1·08; sulphuric acid, 1·30; silica, 23·70; magnesia, 1·40; and loss by calcination, 5·70. A cement of 9 parts sand and 1 part slag cement possessed after twenty-eight days a strength of 20 kilos. per square centimeter, and after 360 days one of 36 kilos.; 1,000 kilos. of this cement cost 22·5 francs and are sold for 40 francs.—Neueste Erfindungen und Erfahrungen.

U healthfulness of the Production of Safety Matches.—The production of safety matches, so-called Swedish matches, is by no means without danger to the health of the workmen. The igniting or dipping composition employed is known to contain, as the most essential ingredients, potassium chlorate and potassium chromate, which latter is added to the igniting mass in the proportion of 3 to 6 per cent.

Since the workmen in the match factories come in contact with the chrome salt in grinding the latter, in the preparation of the dipping and igniting composition, in the production of the tips by dipping as well as in the packing of the finished matches, and several kilos. of this poison is daily atomized over the workrooms, serious sickness frequently occurs with the men. Cutaneous disease, headache, debility, are not rare; very often a perforation of the bridge of the nose results in consequence of ulcerations, the destruction of same being most acute in users of snuff tobacco. The destruction of the bridge of the nose can only be attributed to the potassium chromate, hence we are here dealing with a highly serious trade malady.—Neueste Erfindungen und Erfahrungen.

Metallic Soaps.—Metallic soaps are obtained by means of double decomposition. First a soap solution is produced which is brought to a boil. On the other hand, an equally strong solution of the metallic salt of which the combination is to be made (chlorides and sulphides are employed with preference) is prepared, the boiling solutions are mixed together, and the metallic soap obtained is gathered on a linen cloth, Same is then put on enameled plates and dried, first at 40°; later at 60° C.

Aluminium soap is the most important of all. Dissolved in benzine or oil of turpentine, it furnishes an excellent varnish. It has been proposed to use these solutions for the varnishing of leather; they furthermore serve for the production of water-proof linen and cloths, paper, etc. Jarry recommended this compound for impregnating railroad ties to render them weather proof.

Manganese soap is used as a siccative in the preparation of linseed oil varnish, as well as for a drier to be added to paints.

Zinc soap is used in the same manner as the aforesaid.

Copper soap enters into the composition of gilding wax. Same is also employed for bronzing plaster of Paris articles. For the same purpose, a mixture is made use of consisting of copper soap and iron soap melted in white lead varnish and wax.

Iron soap is used with aluminium soap for waterproofing purposes and for the production of a waterproof varnish.

By using wax instead of a soap, insoluble metallic soaps are obtained, which, melted in oils or wax, impart brilliant colorings to them; but colored waterproof and weather-resisting varnishes may also be produced with them.

Finally, metallic resin soaps may be produced by double decomposition of potash resin soaps and a soluble metal salt. From these, good varnishes are obtained to render paper carriage covers, etc., waterproof; they may also be employed for floor wax or lacquers.—Lack- und Farben Industrie.

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